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FINAL REPORT

OAT AGRONOMY: OPTIMIZING ECONOMIC RETURNS TO OAT PRODUCERS

19970239

Funded by
The Agriculture Development Fund

September 2001

Prepared by: Semi Arid Prairie Research Centre

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102-01346/

Final Report - August 31, 2001
97000239

Oat Agronomy: Optimizing Economic Returns to Oat Producers

William May
Indian Head Research Farm
AAFC and IHARF

This research is funded by Initiative, Saskatchewan Department of Agriculture and Food's ADF, Indian Head Agricultural Research Foundation, Agriculture Agri-Food Canada's Matching Investment Initiative, The Quaker Oats Company, Westco, Cargill, and Can-Oat Milling.

Collaborators on this project are Adrian Johnston, Ramona Mohr, AAFC Brandon, MB, and Brian Rossnagel, University of Saskatchewan,Saskatoon, SK, .

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ABSTRACT

Over 3 million acres or oats are grown in Western Canada. Yet in the last 30 years very little agronomic research has been conducted to help farmer improve the yield and quality of their oat crop. The major objective of this project is to provide producers with better information on optimizing the economics of oat production and the quality of the oats produced.

May 1 and May 15 were the optimum seeding dates for yield and quality. Seeding rate was very important when competition from wild oats occurred or seed emergence was reduced. The optimum rate of fertilizer nitrogen was 54 lbs per acre. In some years the oats were more response to nitrogen when seed in early and mid may than when the oats were seeded in early June. Excess amounts of nitrogen reduced test weight. Swathing below 32% seed moisture resulted in the most consistent yield and quality. AC Assiniboia, Triple Crown, and OT 288 are adapted to direct combining.

EXECUTIVE SUMMARY

Over 3 million acres or oats are grown in Western Canada. Yet in the last 30 years very little agronomic research has been conducted to help farmers improve the yield of their oat crop and the chances of growing a premium quality oat for the milling industry. The major objectives of this project are:

I. To provide producers with better information on optimizing the economics of oats production

II. To increase the ability of producers to consistently grow high quality oats for the processing industry

Three years of data has been gathered from several locations. Most of the previous research conducted on the optimum seeding date of oat has been done outside of western Canada. The objective of this research is measure the effect of planting dates and cultivars on the yield and quality of oats. Four seeding dates, early May, mid May, early June, and mid June and four cultivars, AC Medallion, AC Juniper, CDC Boyer and CDC Pacer were used. Delayed seeding resulted in reduced yield and quality of oats in all three years. Seeding dates had a larger effect on yield and quality than cultivars except when a high level of crown rust was present in the field. Early and mid May planting dates tend to provide farmers with the least amount of risk when growing oats.

The effects of seeding rate and nitrogen rate on oats were examined together. Five seeding rates, 150, 225, 300, 375, and 450 plants/m^2 and five nitrogen rates, 13, 27, 54, 80, and 107 lbs N/acre were used at several locations; Indian Head, Brandon, Melfort, and Weyburn in all three years; at Canora in 1998 and 2000; and at Ituna in 1999 and 2000. Seeding rates are stated as seeds per metre square because of the large variation in kernel size among seed lots. Increasing the seeding rate increased yield and improved seed quality when competition from wild oats occurred or seed emergence was reduced. Yield responses to N varied among site years. Maximum grain yields were achieved at N rates of 27 to 54 lb N/acre at ten site years and at 107 lb N /acre at one site; additional N did not further increase yield. In contrast, at three site years, 13 kg ha^{-1} of applied N produced greater yields than higher rates of N. Test weight decreased as the nitrogen rate was increased at 13 of 17 site years. The effects on other quality factors were less consistent.

The effects of seeding date, nitrogen rate and cultivars on oats were examined together. Three seeding dates, May 1, May 15, and June 1, four nitrogen rates 13, 36, 71 and 107, lbs /acre and two cultivars, AC Assiniboia and CDC Pacer were used, at three locations Indian Head, Brandon, and Melfort in all three years. A forth site near Canora was used in 1999 and 2000. The seed yield was affected by seeding date, rate of applied nitrogen and cultivar. At Melfort and Indian Head the biggest yield increases to applied nitrogen occurred when the oats were seeded on May 1 and May 15 in 1998. At Brandon applications of nitrogen increased yield on all three seeding dates. In 1999, the yield of June 1st planting date was much closer to the other two planting dates. This difference is probably due to the wet and cool summer that occurred in

1999. In 2000 yield decrease as seeding was delayed at all sites. There were differences between the yield of the two cultivars. CDC Pacer tended to out yield or be equal to AC Assiniboia in the first planting while the reverse was true on the last planting date. The test weight tended to decreased as seeding was delayed. When there was a difference between cultivars, CDC Pacer tended to have a higher test weight at low levels of applied nitrogen. As the nitrogen rate increased the test weight of CDC Pacer tended to decrease faster than the test weight of AC Assiniboia.

The effect of seed moisture at swathing on the yield and quality of oats was examined using five seed moisture levels, 50, 41, 32, 23 and 14 percent moisture at two locations, Indian Head and Brandon. The optimum yield and quality were obtained by waiting until the oats reach 32 % seed moisture before swathing the oats.

Differences between straight combining and swathing were examined at two locations, Indian Head and Brandon, in 1998 and 1999, using eight cultivars. Eight cultivars were used to see if any differences among the cultivars could be found for lodging and shattering. No consistent differences could be found between the two harvest methods for yield or quality. The suitability of cultivars for straight combining was affected by crown rust. Crown rust affect yield, quality, dockage and shattering at Brandon in both years and at Indian Head in 1999. The Semi-Dwarf, AC Assiniboia and Triple Crown are cultivars suitable for straight combining. Not enough data is available to evaluate the suitability of most of the cultivars susceptible to crown rust in the absence of crown rust. AC Juniper is not suitable for straight combining.

ACKNOWLEDGEMENTS

This research is funded by Indian Head Agricultural Research Foundation, Agriculture and Agri-Food Canada's Matching Investment Initiative, Saskatchewan Department of Agriculture and Food's Agriculture Development Fund, The Quaker Oats Company, Westco, Cargill, and Can-Oat Milling.

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TECHNICAL REPORT

This three year oat agronomy project has been successfully completed. The locations were Indian Head, Brandon, Canora, Melfort, Saskatoon, and Weyburn. Ituna was used as site in 1999 and 2000. The large number of locations allowed us to quickly gather information over a wide range of environmental conditions.

The increasing demand for high quality processing oats are encouraging more producers to start growing oats or to increase the number of acres of oats they grow. However, very little information is available to help growers make better agronomic decisions when growing oats. Almost no agronomic research has been conducted on oats in Western Canada for the last 50 years. Recommendations made to oat producers in Saskatchewan are based on research conducted in other parts of the North American continent with cultivars not used in Saskatchewan. Agronomic research is needed to optimize oat production to the environmental conditions found in Saskatchewan using the cultivars currently available to growers.

To address these concerns, a strategic planning session was held to determine which agronomic factors are the most limiting to oat producers. A strategic planning session was held to determine which agronomic factors are the most limiting to oat producers. This planning session occurred on July 24, 1997 at the Indian Head Research farm with producers, extension agrologist, scientists, and oat millers in attendance. Through extensive discussion and from the results of a survey, it was determined that the following areas needed immediate attention, the management of seeding, fertility, and harvest, plus, crop rotation, and crop quality. It was decided that we would concentrate on seeding, fertility and harvest management because of their large effect on crop quality. The major objectives of this project are:

(1) To provide producers with better information on optimizing the economics of oat production

(2) To increase the ability of producers to consistently grow high quality oats for the processing industry

To increase the relevancy of this research a collaborative approach is being taken to increase the sites at which these experiments are conducted. Collaborators on this project are Adrian Johnston, AAFC Melfort, SK, Ramona Mohr, AAFC Brandon, MB, and Brian Rossnagel, University of Saskatchewan,Saskatoon, SK.

Materials and Methods

The project has been broken down into five experiments each conducted at more than one location.

98-610) Does the Seed Moisture of Oats at Swathing Affect Seed Yield and Quality?

Experimental Design
One way factorial RCBD with 5 replications using one cultivar
Grain Moisture level at time of swathing: 50, 41, 32, 23, and 14 % on a fresh weight basis
The variety Calibre was used in 1998
Location: Indian Head and Brandon
Parameters to be measured: lodging, yield, test weight, 1000 Kernel weight, % plump kernels, % thin kernels, groat yield, percentage of grain that is removed during cleaning, germination, abnormal seed and dead seed

98-620) Harvest Management

Experimental Design
A two way factorial RCBD with 4 replications.
Harvest System: 1) Swathing and combining 2) straight combining
Cultivars: AC Assiniboia, AC Juniper, AC Preakness, CDC Boyer, CDC Pacer, Derby, Semi Dwarf (OT 288), Triple Crown.
Location: Indian Head, and Brandon,
Parameters to be measured: plant density, plant height, lodging, shattering, days to maturity, grain yield, test weight, 1000 Kernel weight, % plump kernels, % thin kernels, and groat yield.

98-630) Nitrogen rate and Seeding Date

Experimental Design
A three way factorial RCBD with 4 replications
Nitrogen Rate: 0, 40, 80 and 120 kg ha^{-1}
Seeding Date: May 1, May 15, and June 1
Cultivars: Two cultivars will be used.
Location: Indian Head, Brandon, Canora and Melfort
Parameters to be measured: plant density, tiller density, plant height, lodging, days to maturity, grain yield, test weight, 1000 Kernel weight, % plump kernels, % thin kernels, and groat yield.

98-640) Cultivars and Seeding Date

Experimental Design
A two way factorial RCBD with 4 replications
Seeding Date: May 1, May 15, June 1, and June15
Cultivars: AC Assiniboia and CDC Pacer.
Location: Indian Head, Brandon, Melfort, and Saskatoon

Parameters to be measured: plant density, tiller density, plant height, lodging, days to maturity, grain yield, test weight, 1000 Kernel weight, % plump kernels, % thin kernels, and groat yield.

98-650) Nitrogen rate and Seeding Rate

Experimental Design
A two way factorial RCBD with 4 replications using one cultivar
Nitrogen: 0, 30, 60, 90, and 120 kg ha^{-1}
Seeding Rate: 150, 225, 300, 375 and 450 plants m^{-2}
AC Assiniboia was used at the locations considered to have a higher risk of heavy rust disease, Brandon, MB and Weyburn, SK. Due to a problem with seed supply AC Preakness was used at Glenlea. CDC Pacer was used at the other three locations.
Location: Indian Head, Brandon, Melfort, Canora, Weyburn, and Ituna,
Parameters to be measured: plant density, tiller density, plant height, lodging, days to maturity, grain yield, test weight, 1000 Kernel weight, % plump kernels, % thin kernels, and groat yield.

1) Seeding Date

In Western Canada, oats are quite often planted in late May or early June. However, most studies suggest that the optimum planting date should be early in the growing season and as seeding is delayed, seed yield and seed quality is reduced (Ciha 1983; Humphreys et al. 1994 and Schmidt 1960). But, none of these studies were conducted in Western Canada. One study conducted at Indian Head from 1891 to 1894 found that the mid May seeding dates had the highest yield (Saunders 1895). Producers can not plant every crop first, but knowing what their potential reduction in income will be from delaying the planting of oats will help them manage the order in which they plant their crops. In addition four cultivars were used to determine if the optimum seeding date among the cultivars differed.

Materials and Methods

Field experiments were conducted at Brandon, Indian Head, and Melfort in 1998, 1999 and 2000, and in 1998 and 1999 at Saskatoon. The experimental design was a 4 by 4 factorial with four replications except at Saskatoon where a split plot design was used. There were four seeding dates, early May, Mid May, early June, and Mid June and four cultivars, AC Medallion, AC Juniper, CDC Boyer and CDC Pacer. At Brandon, Indian Head and Melfort the plots were direct seeded into standing stubble. At Saskatoon the plots were seeded into tilled soil that had been in fallow for at least one year. The seeding rate for each cultivar was calculated to provide a plant density of 300 plants /m^2. The target level of nitrogen was 100 kg ha^{-1}, as a combination of residual nitrogen and fertilizer nitrogen. Phosphorous, potassium and sulfur were applied as needed

Data was collected on plant density, panicle density, seed density, height, lodging, rust, maturity, seed yield, seed weight, test weight, thin seed, plump seed, groat yield and dockage. The data was analysed using Proc GLM in SAS (SAS 1996) Mean comparisons were done using a protected LSD.

Results and Discussion

In 1998, the general trend at all four locations was that yields decreased as planting was delayed (Table 1.1 and Fig. 1.1). Yields decreased from May15 to June 15, by 61 bushels per acre at Indian Head , 36 bushels per acre at Melfort and Saskatoon. Even at Brandon there was a statistically significant linear decrease in yield as planting was delayed. At Melfort there was an interaction between the cultivars and seeding date (Fig. 1.1). CDC Boyer had a lower yield than the other cultivars when planted at early and mid May. There were significant differences among the cultivars at Saskatoon and Brandon. The differences among cultivars, however, were much smaller than the differences among planting dates, except at Brandon. In other words, if you planted after June 1st and don't like the yield you obtained don't blame the cultivar.

In 1999 the same trends occurred with yields decreased as planting was delayed (Fig. 1. 2). At Melfort the yield of all four cultivars decreased as planting was delayed. No crown rust was observed on the oat plants at Melfort. At Indian Head the rust susceptible cultivars CDC

Pacer and AC Juniper had higher yields than AC Medallion and CDC Boyer on the first planting date (Fig. 1.3). At the mid May planting date there were no differences among the cultivars and as seeding was delayed seed yield of all cultivars declined. However, from early June to mid June the yield of the rust susceptible cultivars CDC Pacer and AC Juniper decreased the most, 60 bu/ac, followed by CDC Boyer, 40 bu/ac, which has some resistance to crown rust and AC Medallion, 24 bu/ac, with the best resistance to crown rust. The amount of crown rust infecting the oat cultivars was fairly constant from early May to early June (Fig. 1.4). After Early June the level of rust infection on AC Juniper, CDC Pacer and CDC Boyer increased while AC Medallion had very little rust. This increase in crown rust occurred at the exact same time that differences occurred among the cultivars. At Brandon, the yield of all cultivars increased from early May to mid May after this the yield of AC Juniper, CDC Pacer and CDC Boyer decreased, while the yield of AC Medallion increased until early June before decreasing (Fig. 1.5). The low yields at Brandon were due to the wet conditions in May and crown rust. The severity of the crown rust increased from mid May to mid June (Fig. 1.6).

In 2000, seed yield at Melfort did not significantly decline as seeding was delayed (Table 1.2). At Brandon there were two sites in 2000 one on a sandy loam and another on a clay loam. On the clay loam, the yield dropped by 36 bu/ac when planting was delayed until May 15th and by another 16 bu/ac when seeding was delayed until June 1 (Table 1.2). When seeding was delayed again until the middle of June yield was decreased by another 62 bu/ac. On the sandy loam the yield was not as high but the yield of all four cultivars decreased when seeded after May 16 (Fig. 1.7). At Indian Head, seed yield decreased after April 26 for AC Juniper and after May 16th for the other three cultivars (Fig. 1.8). Crown rust did not develop on the oats planted on April 26 but it did infect the oats planted in the middle of May or later, helping to lower yields (Fig 1.9).

Producers face two factors, deteriorating environmental conditions and crown rust, which can reduce their yield when they delay seeding their oats.

In 1998, test weight decreased at Indian Head and Melfort as seeding was delayed. The trend at Saskatoon and Brandon was less obvious (Table 1.3). In 1999, at Melfort the mid May seeding date had the best test weights and the test weights of all the cultivars decreased as seeding was delayed (Fig. 1.10). At Indian Head there was a slow decrease in bushel weight from early May to mid May for all the cultivars except AC Medallion (Fig. 1.11). The largest decrease in test weight occurred when seeding was delayed from June 1 to June 15. The bushel weight of both rust susceptible cultivars CDC Pacer and AC Juniper was 26.5 lb bu^{-1}. At Brandon the test weight of CDC Pacer, AC Juniper and CDC Boyer were low at any planting date (Fig. 1.12). There was a general decrease in test weight as seeding was delayed. CDC Medallion was not affected by crown rust and it's test weight did not decrease until mid June.

In 2000, test wight decreased after May 15 at Indian Head while the weight on a sandy loam near Brandon were low no matter when the oats were planted (Fig 1.12). On the clay loam near Brandon all varieties achieved an acceptable test weight on the early May seeding date (Fig. 1.13) after this test weight tended to decline as seeding was delayed except for AC Medallion which increased it's test weight on the mid June seeding date. At Melfort the test weight follower the same trend as the yield and did not decrease as planting was delayed (Fig. 1.14).

As with yield, test weight decreased when planting was delayed especially if rust

susceptible cultivars are grown when crown rust is present. The test weight required by millers varies among the millers. Can-Oat milling requires a test weight of 40.9 lb bu^{-1} (235 g $0.5L^{-1}$) and other millers want 42.5 lb bu^{-1} (245 g $0.5L^{-1}$). Seeding in early or mid May does not guarantee a test weight acceptable to the milling industry but it does improve the chances of a grower having an acceptable test weight.

Conclusions

1) delayed seeding reduced the yield and quality of oats.
2) Seeding date had a much larger affect on yield and quality than cultivar except in the presence of crown rust.
3) Producers incur more risk as seeding is delayed

Table 1.1 The Effect of Seeding Date and Cultivars on the Yield of Oats in 1998

	Indian Head	Saskatoon	Brandon
Planting Date		Bushels/acre	
May 1	127 *a*	-	60.0*a*
May 15	126 *a*	103 *a*	58.2*a*
June 1	91 *b*	94 *b*	48.4*a*
June 15	65 *b*	67 *c*	
Cultivar			
AC Medallion	102.3*a*	85.2*b*	50.4*ab*
CDC Pacer	103.1*a*	94.9*a*	59.8*ab*
AC Juniper	105.1*a*	85.0*b*	48.9*b*
CDC Boyer	99.1*a*	87.0*b*	63.0*a*
CV	9.4	4.7	29
SE	3.4	1.7	5.7

a-c Values for planting date or cultivar within a column followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

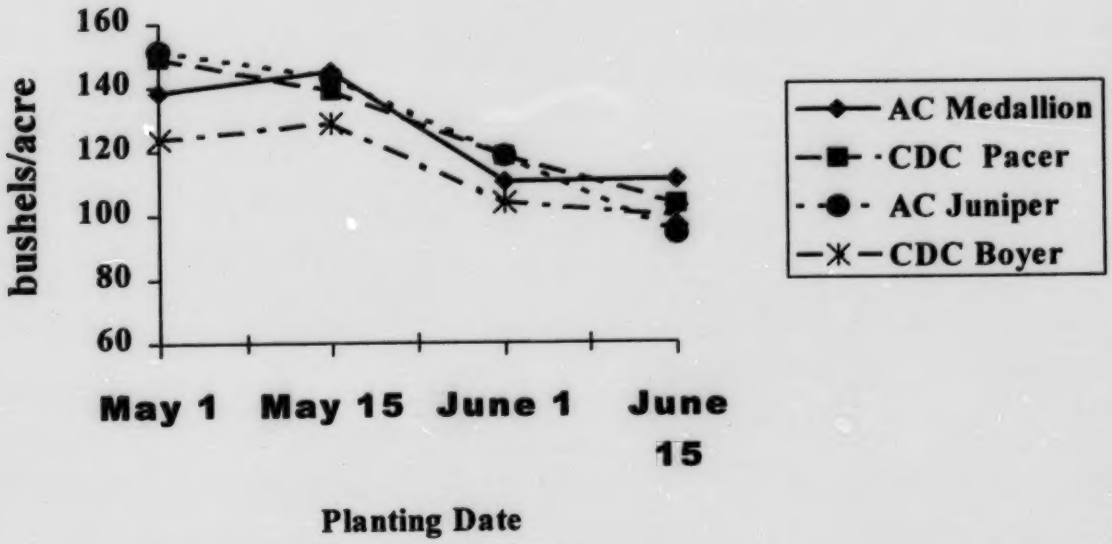

Figure 1.1 The effect of planting date on the yield of four oat cultivars at Melfort in 1998.

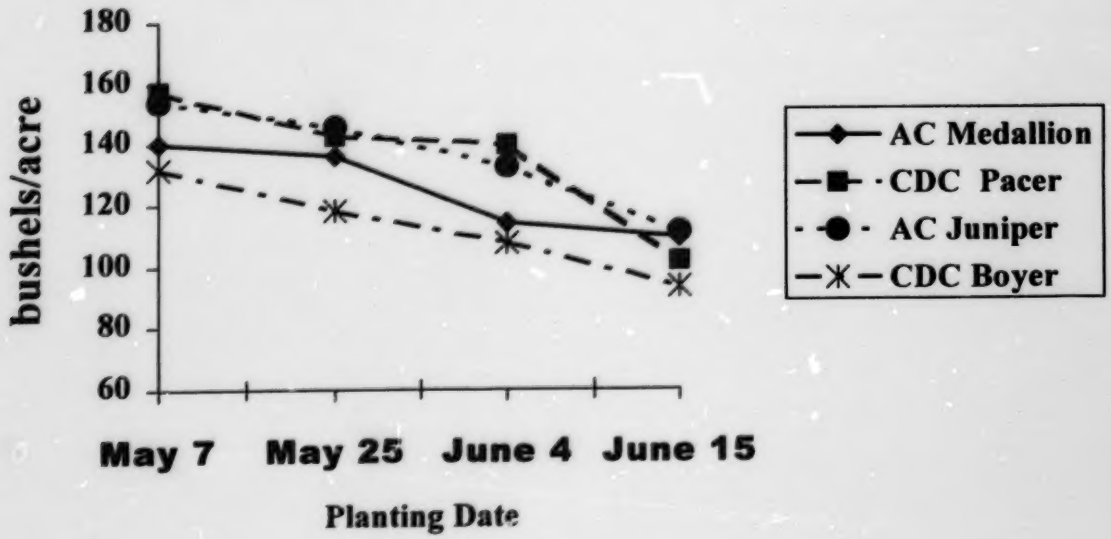

Figure 1.2 The effect of planting date on the yield of four oat cultivars at Melfort in 1999

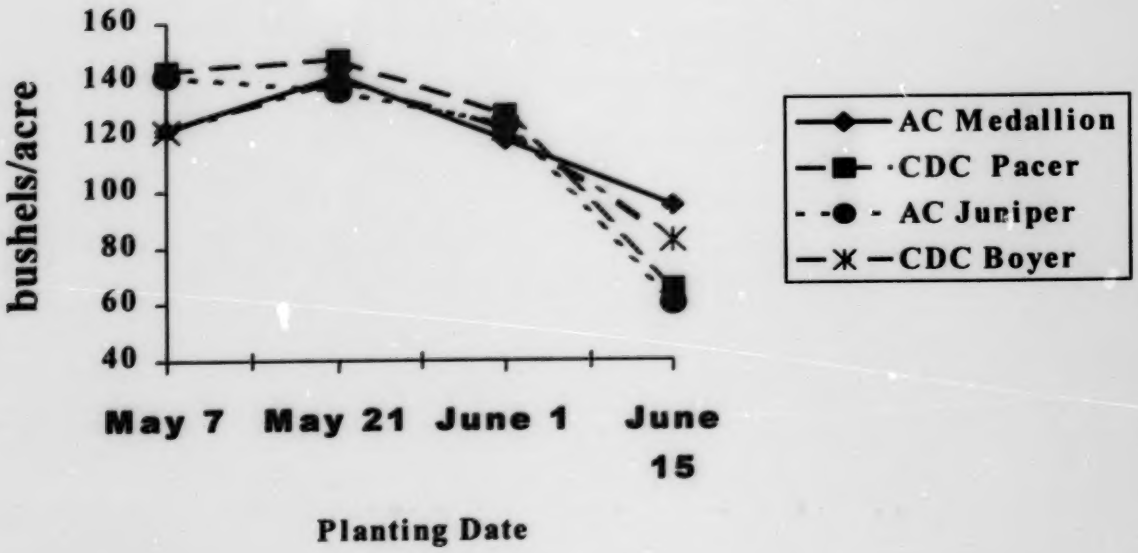

Figure 1.3 The effect of planting date on the yield of four oat cultivars at Indian Head in 1999

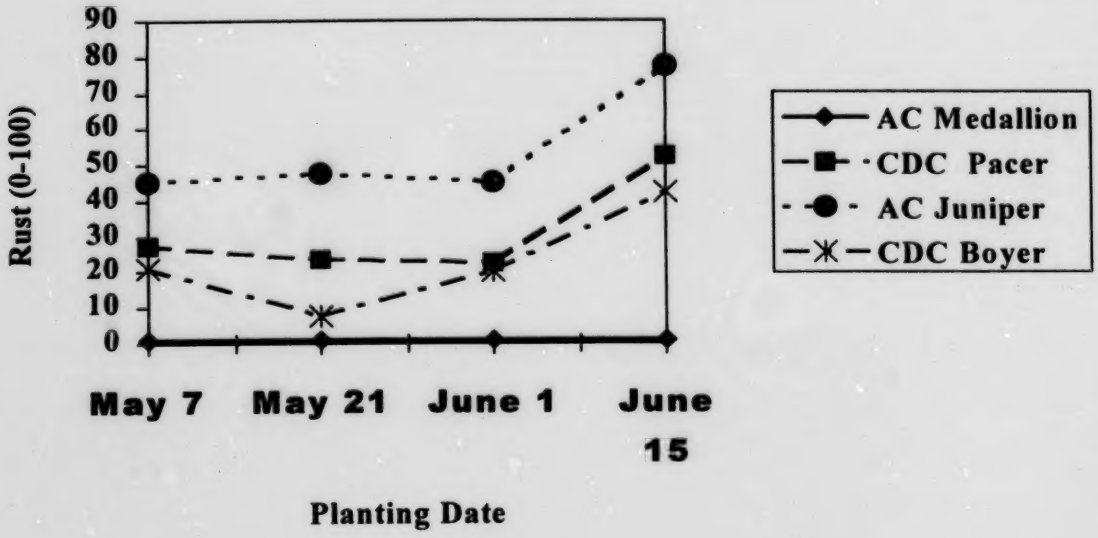

Figure 1.4 The effect of planting date and four oat cultivars on crown rust at Indian Head in 1999.

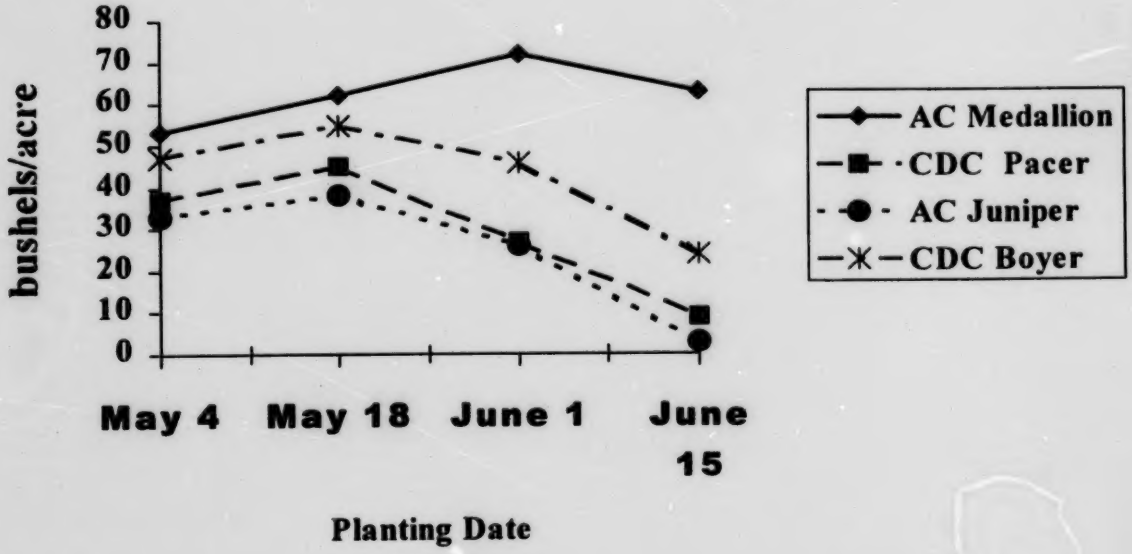

Figure 1.5 The effect of planting date on the yield of four oat cultivars at Brandon in 1999.

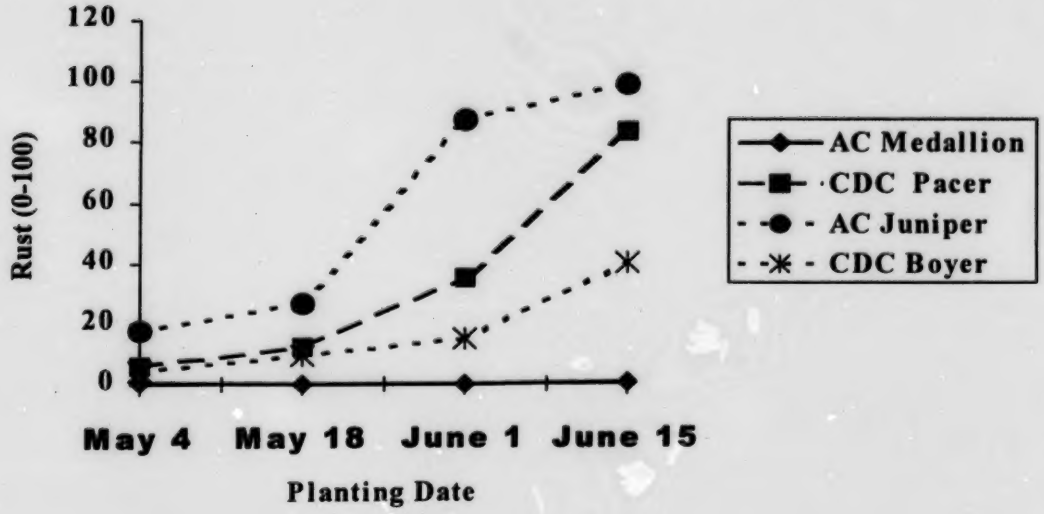

Figure 1.6 The effect of planting date and four oat cultivars on crown rust at Brandon in 1999.

Table 1.2 The Effect of Seeding Date and Cultivars on the Yield of Oats in 2000

	Melfort	Brandon (clay soil)
Planting Date		
May 1	160.0*a*	132.9*a*
May 15	160.6a	96.9*b*
June 1	157.1*a*	80.9c
June 15	146.3*a*	18.8*d*
Cultivar		
AC Medallion	155.1*a*	83.9*a*
CDC Pacer	158.2*a*	77.5*a*
AC Juniper	152.0*a*	87.3*a*
CDC Boyer	158.6*a*	80.7*a*
CV	8.7	14

a-c Values for planting date or cultivar within a column followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

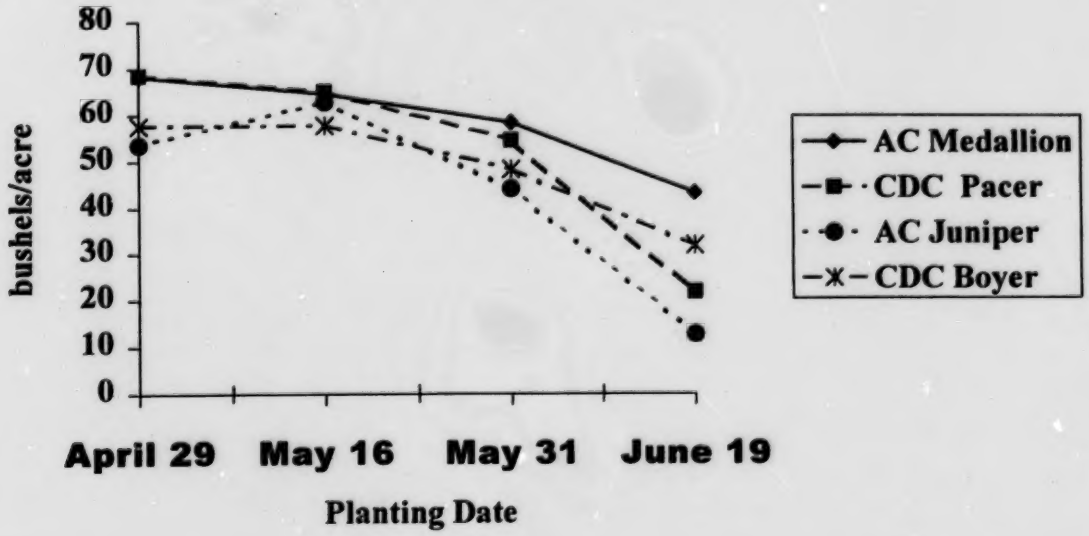

Figure 1.7 The effect of planting date on the yield of four oat cultivars on sandy loam soil near Brandon in 2000.

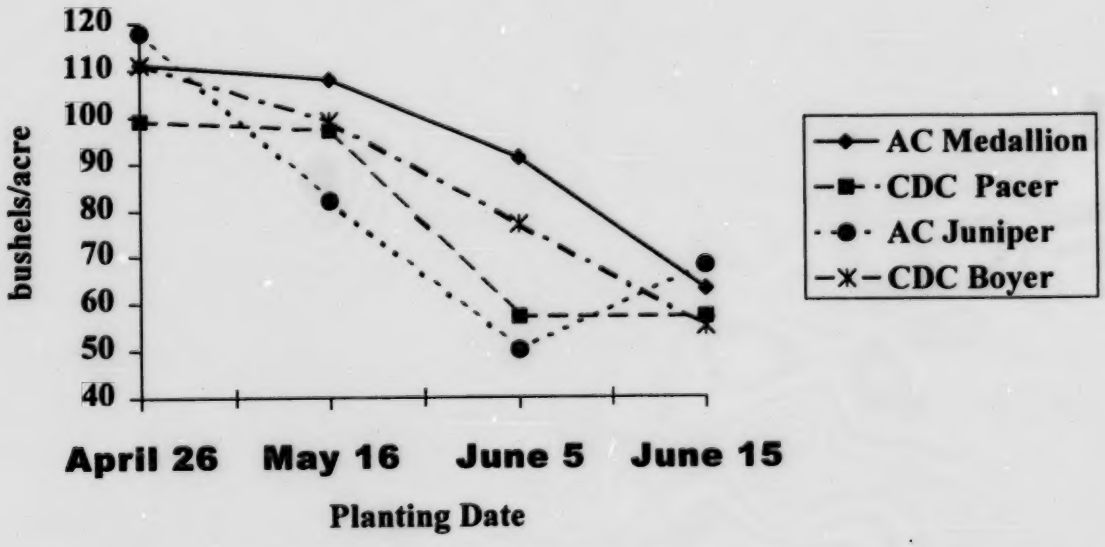

Figure 1.8 The effect of planting date on the yield of four oat cultivars at Indian Head in 2000

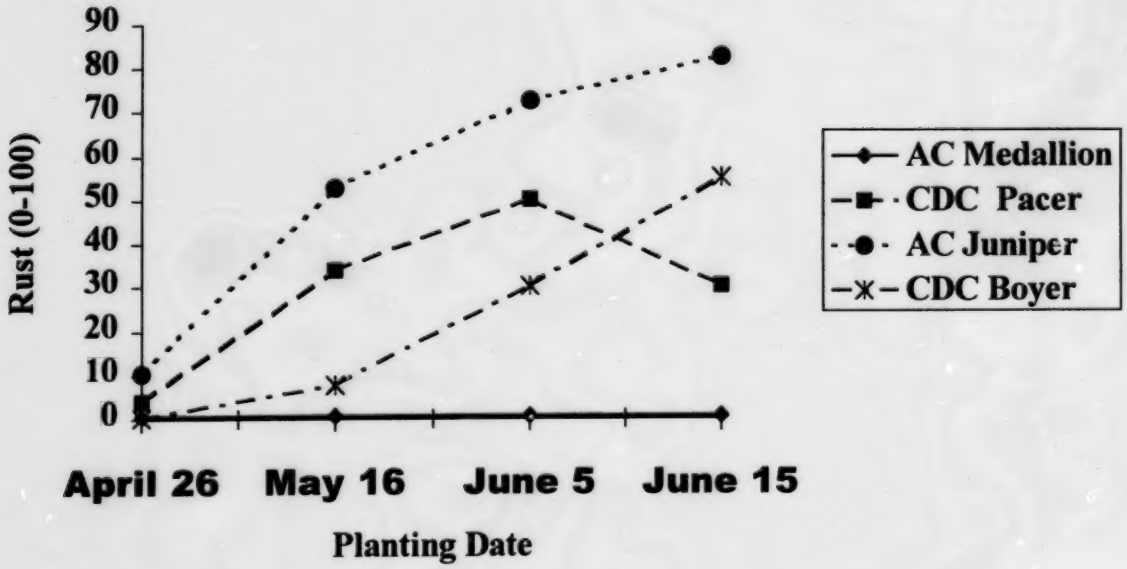

Figure 1.9 The effect of planting date and four oat cultivars on crown rust at Indian Head in 2000.

Table 1.3 The Effect of Seeding Date and Cultivars on the Test Weight of Oats in 1998.

	Indian Head	Saskatoon	Melfort	Brandon
Planting Date		lbs/Bushels		
May 1	42.0*a*		44.1*a*	35.2*b*
May 15	42.0*a*	41.5*ab*	43.8*a*	38.8*a*
June 1	37.2*b*	40.4*b*	41.4*c*	35.3*b*
June 15	37.9*b*	42.6*a*	43.0*b*	
Cultivar				
AC Medallion	40.7*a*	41.2*bc*	43.3*ab*	34.0*b*
CDC Pacer	39.6*b*	42.5*a*	43.8*a*	37.9*a*
AC Juniper	39.1*b*	41.4*b*	42.8b*c*	36.1*ab*
CDC Boyer	39.6*b*	40.9*c*	42.3*c*	37.7*a*
CV	2.8	1.3	2.4	12

a-c Values for planting date or cultivar within a column followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

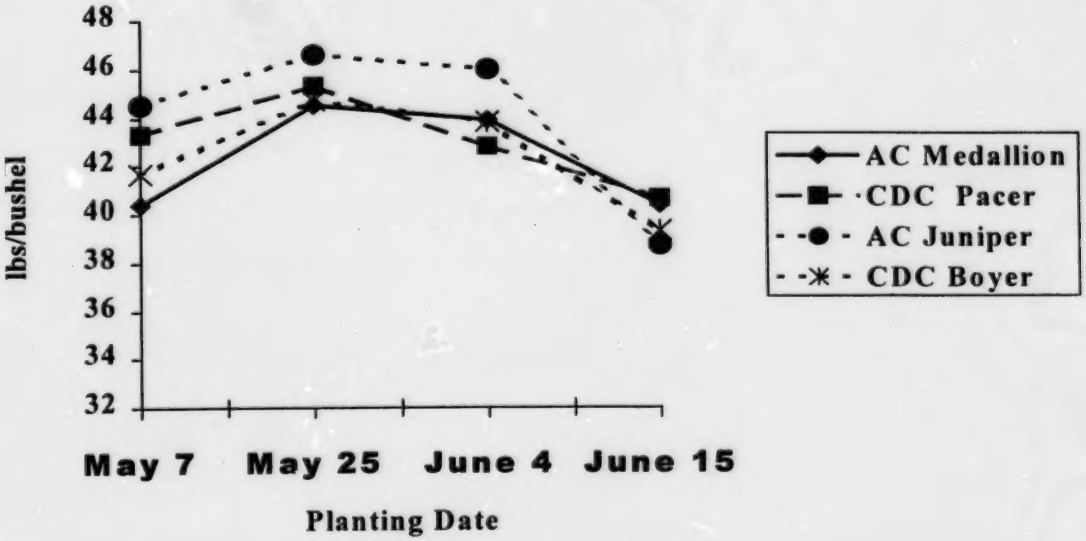

Figure 1.10 The effect of seeding date and cultivars on the test weight of oats at Melfort in 1999.

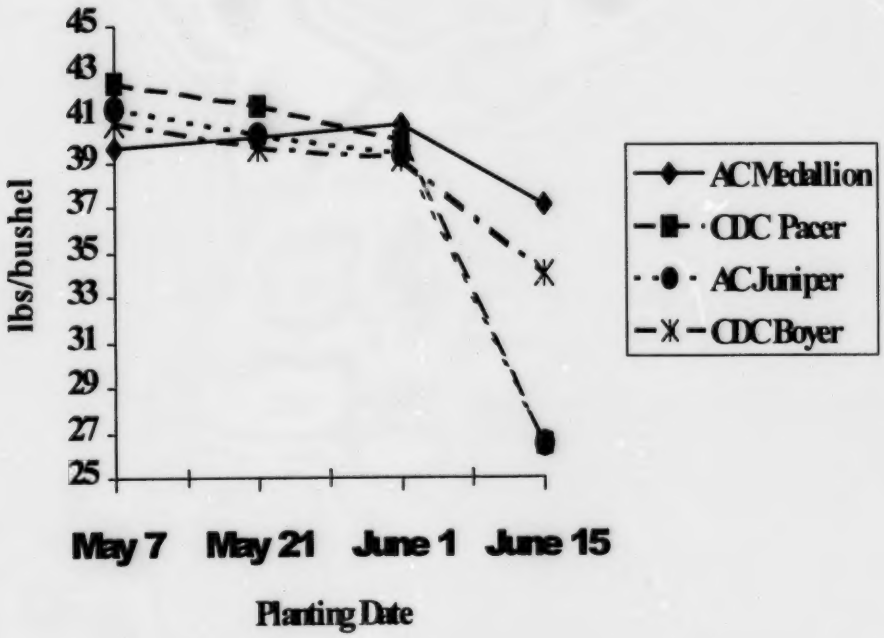

Figure 1.11 The Effect of seeding date and cultivars on the test weight of oats at Indian Head in 1999

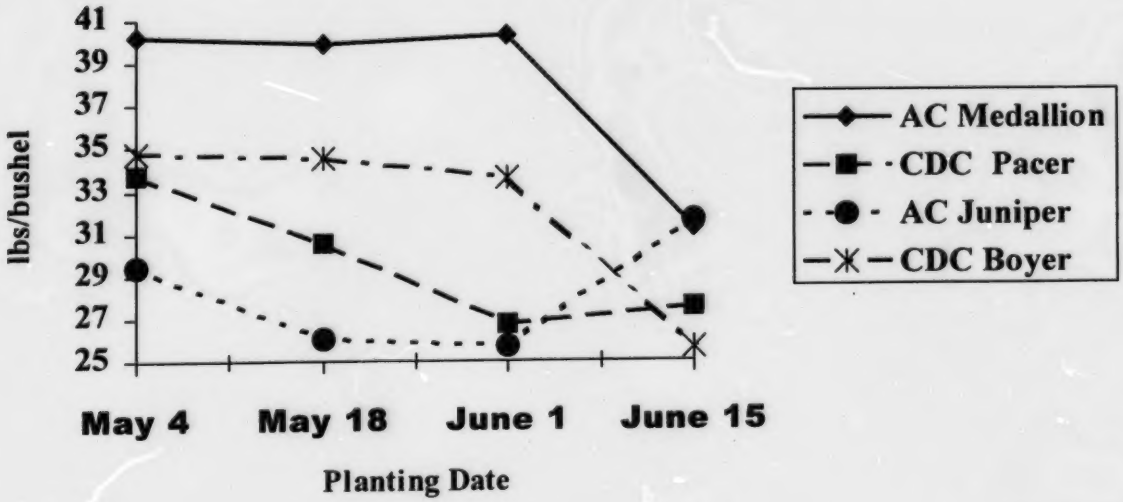

Figure 1.12 The effect of seeding date and cultivars on the test weight of oats at Brandon in 1999.

Table 1.4 The Effect of Seeding Date and Cultivars on the Test Weight of Oats in 2000.

	Indian Head	Brandon (sandy loam)
Planting Date	lbs/bushels	
May 1	41.0*ab*	33.9*a*
May 15	42.2*a*	32.6*a*
June 1	28.1*c*	32.4*a*
June 15	30.3*bc*	30.4*a*
Cultivar		
AC Medallion	39.5a	34.2*a*
CDC Pacer	36.3*a*	32.9*a*
AC Juniper	37.5*a*	29.4*a*
CDC Boyer	36.6*a*	33.2*a*
CV	2.8	7

a-c Values for planting date or cultivar within a column followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

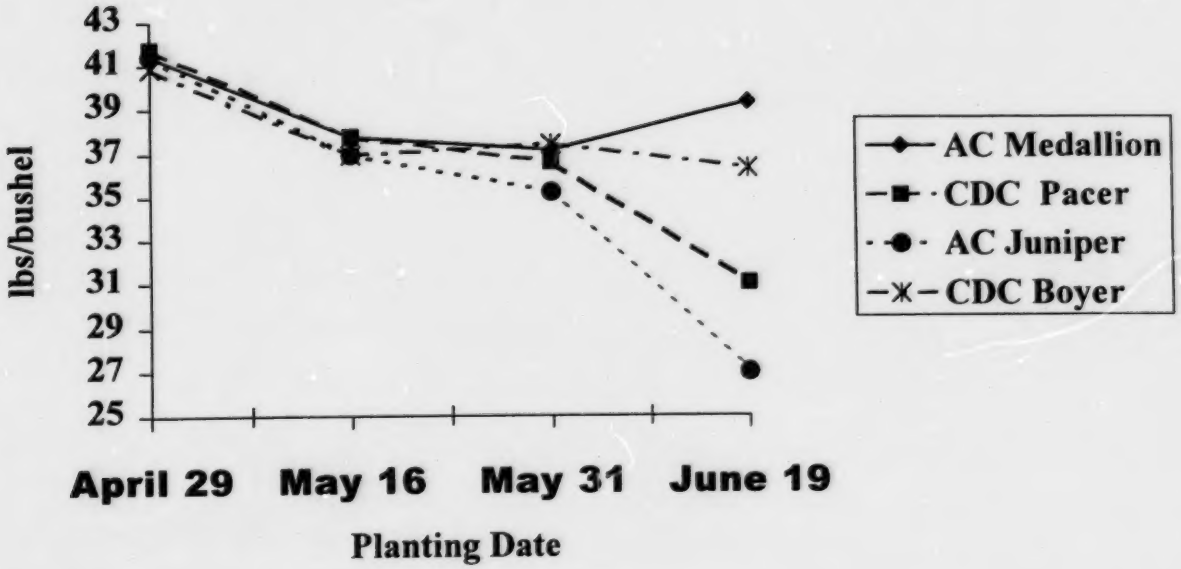

Figure 1.13 The effect of planting date and cultivars on test weight at on a clay loam soil near Brandon in 2000

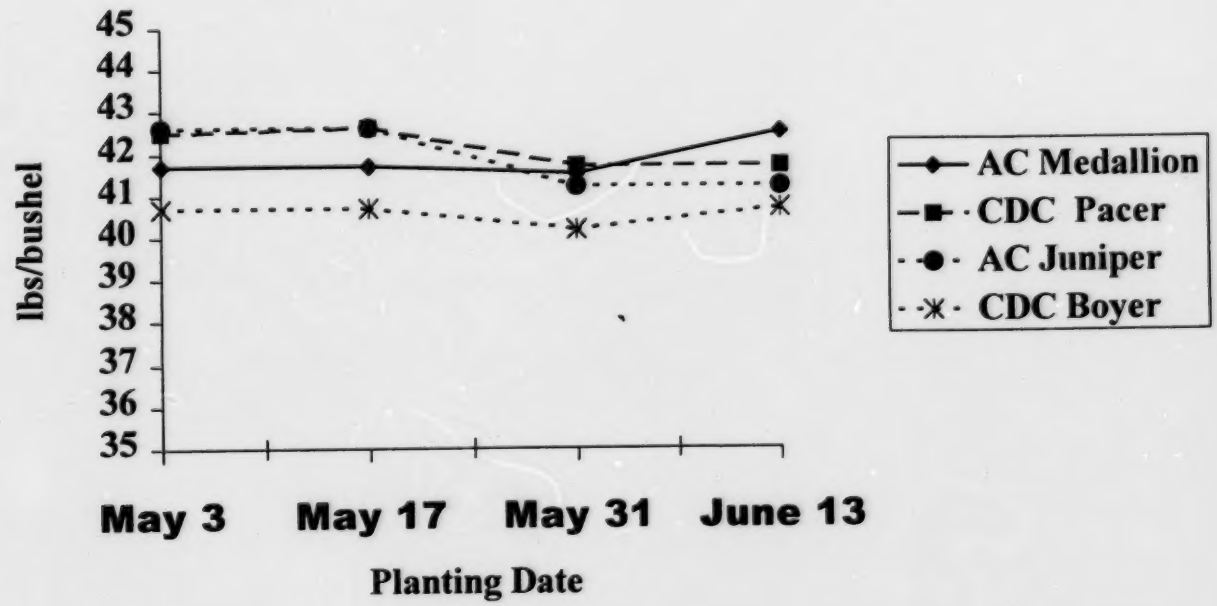

Figure 1.14 The effect of planting date and cultivars on the test weight of oats at Melfort in 2000

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2) Nitrogen Rate and Seeding Rate

The recommended seeding rate for oats in Saskatchewan has been estimated to be between 270 and 323 plants per square metre (25 to 30 per square foot). Unfortunately, very little research has been conducted to verify that this is the optimum plant density, given the new cultivars and changes in production practices. Work conducted 36 years ago in the Peace River region suggested that approximately 300 plants per square metre was the optimum seeding rate. Also, there may be an interaction between seeding rate and nitrogen rate on yield and seed quality. Higher seeding rates usually reduces tillering, and this reduced tillering may result in more uniform and higher quality seed. When working on optimum seeding rate in oats we look at plants/m^2 because of the large variation in kernel size between seed lots of oats. In 1998, to obtain the optimum plant population (300 plants / m^2), seeding rates varied between 99 lb /acre and 125 lb /acre depending on the seed lot. Therefore if a farmer or researcher seeds his oats at 3 bushels per acre every year he could be experiencing large variations in plant population. In general, the higher the bushel weight, the more bushels per acre are required to get the same number of seeds per metre square. The best way to calculate your seeding rate is to weight out 100 oat kernels and multiply by ten to get a 1000 kernel weight for the seed lot you will be using. Once you have the 1000 kernel weight, Saskatchewan Agriculture and Food have published a fact sheet that will help you calculate your seeding rate. In addition, Alberta Agriculture, Food and Rural Development have a web site (www.agric.gov.ab.ca) that can be used to calculate your seeding rate once you have the 1000 kernel weight of your seed lot. To determine the optimum seeding rate and nitrogen rate the same test was conducted at Indian Head, Weyburn, Canora, Ituna and Melfort in Saskatchewan and at Brandon in Manitoba.

Increasing the seeding rate had an effect on the yield components of oats. At all 18 site years as expected the plant density increased as the seeding rate increased (Tables 2.1 to 2.3, not all data shown). The panicles per metre square increased as the seeding rate increased at all site years except at Melfort in 1999 and 2000. Panicles/m^2 consist of two yield components, plants/m^2 and panicles/plant. This indicates that at most locations tillering (panicles/plant) did not completely compensate for the different seeding rates. The next yield component is seeds per panicle. But to understand how seeds per panicle is working in concert with the two previous yield components we need to look at seeds/m^2, which is the summation of all three yield components. As the seeding rate increased seeds/m^2 increased at 7 site years, decreased at 2 site years, did not change at 8 site years (Tables 2.1 to 2.3, not all data shown). At Indian head in 1998, there was an interaction between the seeding rate and nitrogen rate for seeds/m^2. At the 8 site years where the seeding rate did not affect the seeds/m^2, seeding rate did not affect seed yield. This indicates that the combination of tillering (panicles/plant) and seeds per panicle could compensate for the initial differences in plant density. At the two site years, where the seeds/m^2 decreased as the seeding rate increased, an interaction between seeding rate and nitrogen rate for yield occurred. The same interaction between seeding rate and nitrogen rate for yield occurred when their was an interaction between seeding rate and nitrogen rate for seeds/m^2. At all 7 sites where seeds/m^2 increased as seeding rate increased the yield increased as the seeding rate increased. This indicates that if there is a significant difference in seeds/m^2 the last yield component kernel weight can not usually compensate for this difference resulting in a significant

difference in yield.

The next question is why where the yield components unable to compensate for the initial differences in seeding rate. At 4 of the 7 site years, Weyburn in1998, 1999, 2000 and Indian Head in 2000 there was a significant amount of wild oats. The other 14 site years did not have a significant amount of wild oats. It appears that the tame oats were less competitive at lower seeding rates allowing the wild oats to suppress tillering and seeds per panicle of the tame oats which in turn reduced yield. One of the 7 site years, Brandon in 1999, the plant density at the lowest seeding rate was 77 and the site year with the next lowest plant density was 103 plants/m^2 and most site years were close to or above the target plant density of 150 plants/m^2. The oats were unable to compensate for the low plant density of 77 plants/m^2 resulting in the lower yields observed. The other 2 site years that responding to increasing the seeding rate with increased seed yield were the clay sites at Brandon in 2000 and Canora in 2000. At the present time I can not identify the factors that prevented the oats from completely compensating for the different seeding rates. High yields can be obtained with low seeding rates if nothing goes wrong. However, if you use low seeding rates, yield reductions can occur, if any mistakes are made that further reduce the plant stand or wild oats are present in the farmers field.

During the three years that the study was conducted, increasing the rate of nitrogen affected the yield components of oats. At 5 out of 18 of the site years increasing the nitrogen rate tended to lower plant density, however, at 17 out of 18 of the site years increasing nitrogen increased the number of panicles/m^2 (Tables 2.1 to 2.3, not all data shown). This indicates that the oat plants used the extra nitrogen to tiller (panicles per plant) thereby compensating for any reduction in plant density. Increasing the rate of applied nitrogen increased seeds/m^2 and seed yield at 15 of the 18 site years. However, at three site years the seeds/m^2 did not increase and seed yield decreased. Kernel weight decreased at 15 of the 18 site years as the rate of nitrogen increased (data not shown).

Over the course of the study, 4 site years out of 18 had an interaction between seeding rate and nitrogen for yield. Of the remaining 14 site years the response of seed yield varied (Tables 2.4 to 2.6); three site years did not respond to the addition of any nitrogen fertilizer; three site years responded when the nitrogen rate was increased from 13 to 27 lbs of applied nitrogen per acre $^{-1}$; seven site years responded when the nitrogen rate was increased from 27 to 54 lbs of applied nitrogen per acre $^{-1}$; one site year responded when the nitrogen rate was increased to 107 lbs of applied nitrogen per acre $^{-1}$.

The residual nitrogen in 1998 at Indian Head, Brandon, Canora and Melfort was 55, 24, 27, and 25 lbs/acre, respectively. The residual nitrogen in 1999, at Indian Head, the City site near Brandon, Ituna, Melfort and Weyburn was 42, 42, 42, 21 and 25. In 2000, the residual nitrogen at Indian Head, Canora, Brandon- clay loam, Brandon - Sandy loam and Melfort was 30, 42, 24, 17, and 26 lbs/acre, respectively.

The four times an interaction between seeding rate and nitrogen rate for seed yield occurred the response was different each time. In 1998, at Weyburn all the nitrogen rates increased in yield as the seeding rate increased (Fig. 2.1). The interaction occurred because the shape of the response curve was different among nitrogen rates. This was a site with an infestation of wild oats. At Indian Head, the grain yield of the two lowest levels of nitrogen decreased as the seeding rates increased (Fig. 2.2). At Melfort in 1999 there was no consistent

trend to explain the interaction (Fig. 2.3). The lowest nitrogen rate appears to be lower in yield than the rates except at a plant density of 300 seeds/m^2. At the sandy loam site near Brandon in 2000, the yield decreased as the seeding rate increased at just the two highest rates of nitrogen (Fig. 2.4). This is the opposite of the response that occurred at Indian Head in 1998.

The nitrogen rate had a larger effect on lodging than seeding rate. An interaction occurred between nitrogen rate and seeding rate at 3 of the17 site years. Of the remaining 14 site years increasing the seeding rate increased lodging at 8 site years and increasing the nitrogen rate increased lodging at 11 of 14 site years. The average increase in the lodging rating from increasing the seeding rate was 1.4 with the largest increase at any site year being 2.5. On the other hand, the average increase in the lodging rating from increasing the nitrogen rate was 3.2 with the largest at any site year being 5.2. When an interaction occurred between seeding rate and nitrogen rate the most lodging occurred at the highest seeding rate and lodging rate. The lodging at Indian Head in 1999 is the best example of this response (Fig. 2.5). Therefore, the risk to the farmer of increasing his or her lodging is much greater when the farmer increases the nitrogen rate than when the seeding rate is increased.

Seeding rate and nitrogen rate had a direct effect on the percentage of wild oats in the harvested sample at the four site years where wild oats were present. At all four site years increasing the seeding rate lowered the percentage of wild oats in the harvested sample (Table 2.8); while, increasing the nitrogen rate increased the percentage of wild oats in the harvested sample at 2 of the 4 site years.

Nitrogen rate and seeding rate affected test weight. An interaction between seeding rate and nitrogen rate occurred at one site year, Canora in 1998. At the remaining 17 site years, test weight decreased at 13 site years as the rate of nitrogen was increased (Tables 2.9 to 2.11) lowering the quality and value of the oats. Combined with the lack of yield response to high rates of nitrogen, growers using high rates of nitrogen are probably reducing their net return. Increasing the seeding rate brought about small but significant increases in test weight at 6 out of the 17 site years (Tables 2.9 to 2.11). Increasing the seeding rate never decreased the test weight.

In conclusion, high seeding rates provide insurance on the yield potential of oats. It provides insurance against poor stand establishment due to planting conditions or human error, competition from wild oats, and partial buffering against poor growing conditions during the growing season. On the other hand, high rates of nitrogen do not consistently increase yield but they do consistently reduce kernel and test weight. The data from this experiment can not support the application of more than 54 lbs /acre of nitrogen on oats in Saskatchewan and western Manitoba.

Table 2.1 The effect of seeding rate and nitrogen rate on plant and panicle density.

	1998						1999					
	Weyburn			Indian Head			Weyburn			Brandon (clay)		
Seeding Rate	Plant Density	Panicle Density	Seed Density	Plant Density	Panicle Density	Seed Density	Plant Density	Panicle Density	Seed Density	Plant Density	Panicle Density	Seed Density
seeds /m²	plants /m²	panicles /m²	seeds/m²	plants /m²	panicles /m²	seeds/m²	plants /m²	panicles /m²	seeds/m²	plants /m²	panicles /m²	seeds/m²
150	103*d*	249*d*	7093*d*	157*e*	306*d*	13272	167*e*	263*c*	7070*c*	77	284*d*	7868*c*
225	137*c*	307*c*	8422*c*	213*d*	345*c*	13166	207*d*	287*b*	7381*c*	100	328*bc*	8486*b*
300	167b	349*b*	9482*b*	258*c*	378*b*	12392	269*c*	308*b*	7995*b*	120	322*c*	9023*ab*
375	173*b*	370*b*	9503*b*	318*b*	388*ab*	12085	320*b*	332*a*	8556*a*	150	349*b*	9300*a*
450	233*a*	459*a*	10367*a*	384*a*	409*a*	11401	363*a*	342*a*	9030*a*	210	378*a*	89984*ab*
Nitrogen Rate												
13	172*a*	315*b*	8312*c*	286*a*	342*c*	10458	270*a*	287*c*	7808*a*	142	328*a*	8907*a*
27	169*a*	317*b*	9102*ab*	270*ab*	357*bc*	11497	281*a*	301*bc*	8337*a*	147	332*a*	8938*a*
54	158*a*	345*ab*	9626*a*	267*b*	391*a*	13008	258*a*	299*bc*	7931*a*	135	334*a*	8345*a*
80	160*a*	376*a*	9158*ab*	263*b*	380*ab*	13463	264*a*	312*ab*	8042*a*	121	330*a*	8839*a*
107	154*a*	380*a*	8669*bc*	243*c*	358*bc*	13888	252*a*	332*a*	7914*a*	112	337*a*	8632*a*
CV	16	16	14	10.4	10.7		15	11	10	20	11	11

a-e Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 2.2 The effect of seeding rate and nitrogen rate on plant and panicle density.

	1999			2000								
	Melfort			Weyburn			Indian Head			Brandon (clay)		
Seeding Rate	Plant Density	Panicle Density	Seed Density	Plant Density	Panicle Density	Seed Density	Plant Density	Panicle Density	Seed Density	Plant Density	Panicle Density	Seed Density
seeds /m²	plants /m²	panicles /m²	seeds/m²	plants /m²	panicles /m²	seeds/m²	plants /m²	panicles /m²	seeds/m²	plants /m²	panicles /m²	seeds/m²
150	110*d*	369*a*	14768*a*	152*e*	170	3648*d*	146*e*	264*c*	6607*c*	164*e*	245*d*	6832*bc*
225	149*c*	367*a*	14124*abc*	197*d*	184	4284*c*	194*d*	312*b*	6726*bc*	229*d*	249*d*	6682*c*
300	179*b*	387*a*	14664*ab*	235*c*	226	5033*b*	246*c*	326*b*	7284*abc*	275*c*	280*c*	7275*ab*
375	211*a*	401*a*	13730*c*	273*b*	238	5115*b*	286*b*	334*ab*	7477*ab*	325*b*	314*b*	7410*a*
450	208*a*	405*a*	14000*bc*	321*a*	267	5634*a*	355*a*	358*a*	7818*a*	379*a*	341*a*	7153*ab*
Nitrogen Rate												
13	173*a*	339*c*	12330*c*	232*a*	202	3647*d*	238*a*	252*b*	6017*c*	275*a*	251*c*	4940*d*
27	171*a*	348*c*	14000*b*	226*a*	214	4520*c*	241*a*	278*b*	6165*c*	271*a*	271*bc*	6587*c*
54	169*a*	392*b*	15091*a*	236*a*	220	4910*b*	255*a*	345*a*	7426*b*	267*a*	291*ab*	7656*b*
80	176*a*	418*ab*	15080*a*	239*a*	221	5200*ab*	249*a*	356*a*	7892*ab*	287*a*	310*a*	8139*a*
107	170*a*	430*a*	14784*a*	245*a*	227	5438*a*	244*a*	263*a*	8273*a*	273*a*	306*a*	8017*ab*
CV	20	14	14	15	11	12	10	15	17	15	15	10

a-e Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 2.3 The effect of seeding rate and nitrogen rate on plant and panicle density.

	2000					
	Brandon (sandy loam)			Canora		
Seeding Rate	Plant Density	Panicle Density	Seed Density	Plant Density	Panicle Density	Seed Density
seeds /m^2	plants /m^2	panicles /m^2	seeds/m^2	plants /m^2	panicles /m^2	seeds/m^2
150	158*e*	300*c*	8239*a*	161*e*	372*d*	10666*c*
225	204*d*	312*c*	7878*ab*	208*d*	401*c*	11655*bc*
300	280*c*	354*b*	7803*abc*	245*c*	428*c*	13032*a*
375	318*b*	363*b*	7611*bc*	303*b*	462*b*	11806*abc*
450	386*a*	407*a*	7287*c*	337*a*	507*a*	12629*ab*
Nitrogen Rate						
13	270*a*	302*c*	5793*c*	263*a*	397*c*	10212*b*
27	265*a*	320*c*	7363*b*	259*a*	400*c*	10809*b*
54	268*a*	356*b*	8754*a*	249*a*	436*c*	12652*a*
80	271*a*	377*ab*	8706*a*	239*a*	457*ab*	12714*a*
107	271*a*	382*a*	8276*a*	244*a*	480*a*	13400*a*
CV	11	11	11	11	10	18

a-e Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 2.4 The effect of seeding rate and nitrogen rate on oat yield in 1998.

	Yield		
	Melfort	Canora	Brandon
Seeding Rate			clay loam
seeds /m^2		bushels /acre	
150	132.9*a*	92.5*a*	79.0*a*
225	126.5*a*	98.3*a*	74.7*a*
300	127.9*a*	96.8*a*	71.2*a*
375	126.1*a*	97.1*a*	72.9*a*
450	128.4*a*	101.8*a*	77.5*a*
Nitrogen Rate			
13	118.3*c*	85.9*b*	58.5*d*
27	125.8*b*	99.1*a*	63.4*d*
54	130.9*ab*	102.2*a*	73.0*c*
80	132.9*a*	100.9*a*	84.5*b*
107	133.9*a*	98.3*a*	95.8*a*
CV	7.4	13	15

a-d Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 2.5 The effect of seeding rate and nitrogen rate on oat yield in 1999.

	Yield				
	Weyburn	Ituna	Indian Head	Brandon	
Seeding Rate				clay	loam
seeds /m^2			bushels /acre		
150	70.0*c*	108*a*	133*a*	80*c*	105*a*
225	73.7*c*	110*a*	133*a*	88*b*	112*a*
300	80.7*b*	110*a*	133*a*	94*a*	110*a*
375	85.3*ab*	115*a*	131*a*	97*a*	110*a*
450	89.3*a*	114*a*	130*a*	96*a*	115*a*
Nitrogen Rate					
13	80.9*ab*	100*b*	126*b*	95*a*	111*ab*
27	84.2*a*	111*a*	133*a*	94*ab*	117*a*
54	77.8*b*	119*a*	137*a*	89*bc*	116*a*
80	79.0*b*	112*a*	134*a*	90*abc*	107*bc*
107	76.9*b*	114*a*	133*a*	87*c*	101*c*
CV	9	11	5.4	10	11

a-c Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 2.6 The effect of seeding rate and nitrogen rate on oat yield in 2000.

	Yield					
	Weyburn	Ituna	Indian Head	Canora	Melfort	Brandon
Seeding Rate						clay loam
seeds /m²	bushels /acre					
150	44.0*d*	96.3*a*	92.5*c*	140.6*b*	153.8*a*	87.5*b*
225	52.2*c*	94.5*a*	94.9*bc*	142.0*b*	156.9*a*	86.4*b*
300	61.2*b*	91.7*a*	104.7*ab*	144.7*ab*	159.7*a*	91.3*ab*
375	61.6*b*	93.5*a*	107.2*a*	144.5*ab*	154.6*a*	95.4*a*
450	67.6*a*	91.7*a*	111.9*a*	149.6*a*	158.6*a*	91.2*ab*
Nitrogen Rate						
13	46.4*c*	76.4*c*	86.1*b*	130.9*c*	147.9*b*	63.7*c*
27	55.9*b*	89.8*b*	93.5*b*	140.5*b*	147.9*b*	85.3*b*
54	59.4*ab*	101.2*a*	105.6*a*	150.0*a*	161.5*a*	98.9*a*
80	61.1*a*	100.1*a*	111.7*a*	150.3*a*	163.8*a*	102.4*a*
107	63.9*a*	100.0*a*	110.6*a*	149.7*a*	162.5*a*	101.4*a*
CV	13	12	16	6.3	7.6	10

a-d Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

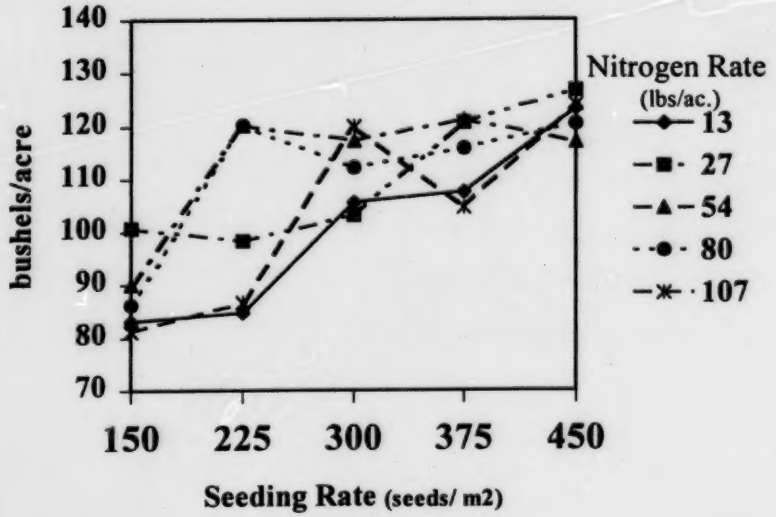

Figure 2.1 The effect of seeding rate and nitrogen fertilizer on the seed yield of oats at Weyburn in 1998

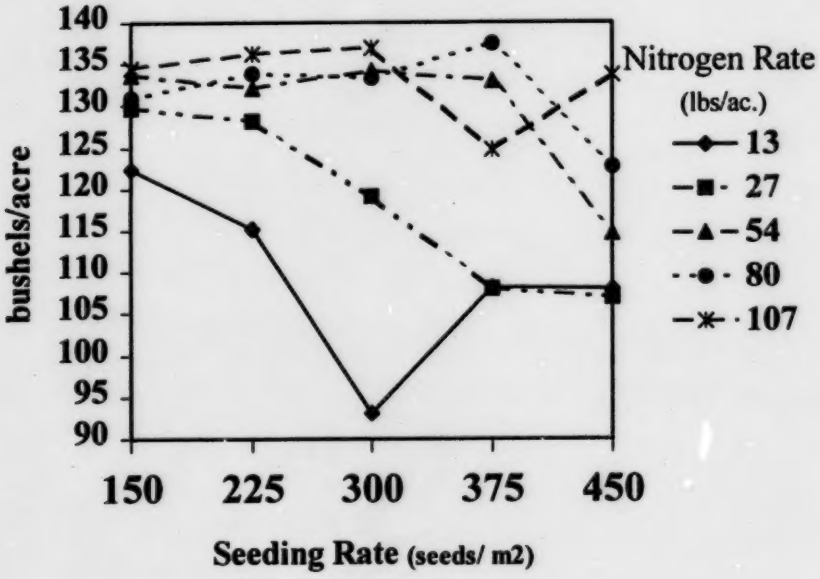

Figure 2.2 The effect of seeding rate and nitrogen fertilizer on the seed yield of oats at Indian Head in 1998

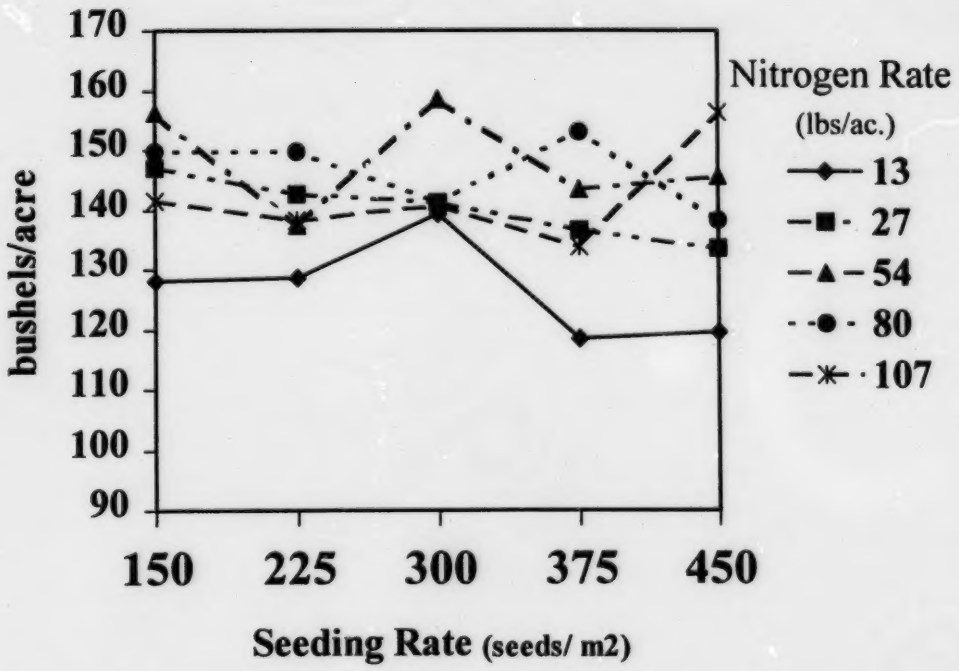

Figure 2.3 The effect of seeding rate and nitrogen fertilizer on the seed yield of oats at Melfort in 1999

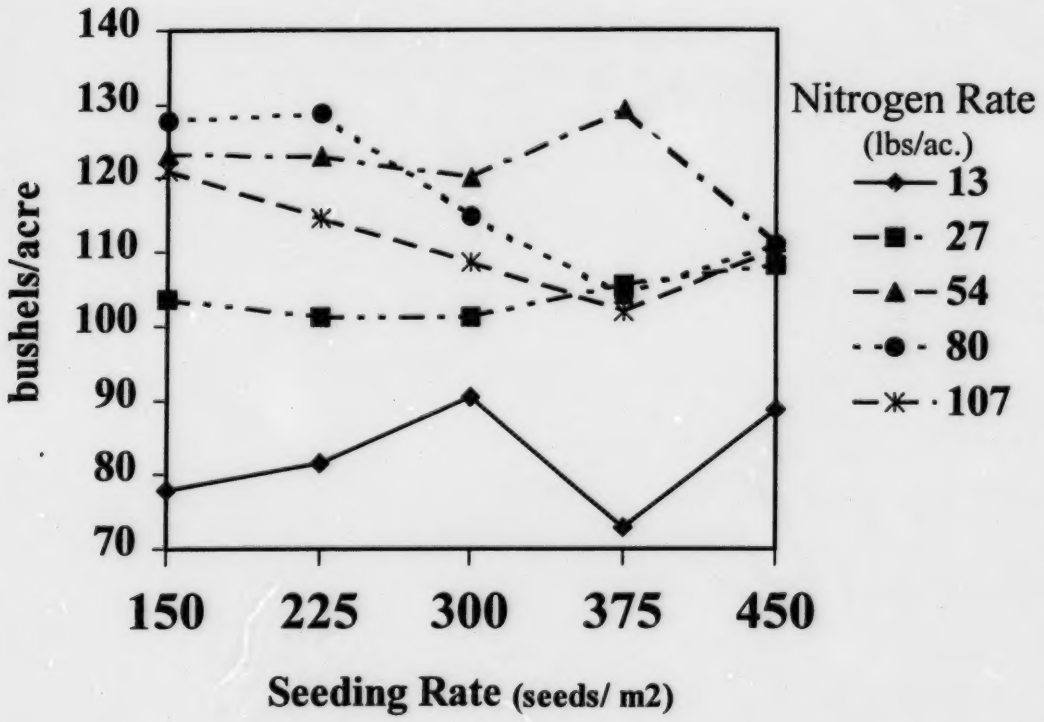

Figure 2.4 The effect of seeding rate and nitrogen fertilizer on the seed yield of oats on a sandy loam soil near Brandon in 2000

Table 2.7 The effect of seeding rate and nitrogen rate on lodging.

	1998					1999						2000					
Seeding Rate	Indian Head	Brandon	Melfort	Canora	Weyburn	Indian Head	Brandon		Melfort	Weyburn	Ituna	Indian Head	Brandon		Melfort	Canora	Ituna
							Clay	Loam					Clay	Loam			
seeds/m²										(1-9)							
150	1.9*a*	2.0*a*	1.0*b*	3.8*a*	3.7*d*	2.8	1.2*a*	4.8*a*	1	2.0*a*	3.4*c*	3.5*b*	5.9*c*	5.2*c*	1.4	3.2*c*	2.6*b*
225	2.0*a*	2.2*a*	1.1*b*	4.4*a*	4.4*c*	3.2	1.0*a*	5.3*a*	2.7	1.9*a*	3.8*c*	3.7*b*	6.2*bc*	6.2*b*	2.2	3.8*b*	2.6*b*
300	2.1*a*	1.9*a*	1.4*b*	4.5*a*	4.8*bc*	3.6	1.0*a*	5.4*a*	2.8	2.0*a*	4.4*abc*	4.0*ab*	6.9*ab*	6.8*a*	1.9	4.1*ab*	3.0*ab*
375	2.0*a*	2.1*a*	2.1*a*	4.8*a*	5.1*b*	4	1.3*a*	5.2*a*	2.2	2.4*a*	5.0*a*	4.6*a*	7.2*a*	6.8*a*	2.1	4.4*a*	3.5*a*
450	1.9*a*	1.8*a*	2.2*a*	4.9*a*	6.2*a*	4.6	1.5*a*	5.8*a*	2	2.5*a*	4.7*a*	4.5*a*	7.0*a*	6.7*ab*	2.5	4.6*a*	3.2*ab*
Nitrogen Rate																	
13	1.2*c*	1.2*c*	1.2*a*	3.3*d*	4.4*a*	2.5	1.1*a*	2.4*d*	1	1.3*c*	1.9*c*	2.1	3.6*c*	3.0*c*	1.1	1.9	2.0*b*
27	1.4*c*	1.8*b*	1.3*a*	3.9*cd*	4.7*a*	3	1.3*a*	4.2*c*	1.1	1.8*bc*	2.7*c*	2.9*d*	5.7*b*	6.2*b*	1.1	2.6*c*	2.5*b*
54	2.0*b*	2.3*a*	1.8*a*	4.4*bc*	5.0*a*	3.6	1.0*a*	5.6*b*	2	2.1*b*	5.0*b*	4.1*c*	8.0*a*	6.8*b*	1.7	3.7*c*	3.3*a*
80	2.6*a*	2.3*a*	1.8*a*	5.1*ab*	5.0*a*	4.2	1.2*a*	7.2*a*	3.4	2.7*a*	5.5*ab*	5.2*b*	7.9*a*	7.6*a*	2.6	5.3*b*	3.3*a*
107	2.7*a*	2.3*a*	1.8*a*	5.6*a*	5.0*a*	5	1.3*a*	7.0*a*	3.2	3.0*a*	6.1*a*	6.1*a*	8.1*a*	8.2*a*	3.5	6.5*a*	3.8*a*
CV	24	29	59	28	22	18	60	25	12	40	41	27	19	16	65	23	34

a-d Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD. If values in a column do not have letters there was an interaction between seeding rate and nitrogen rate for lodging.

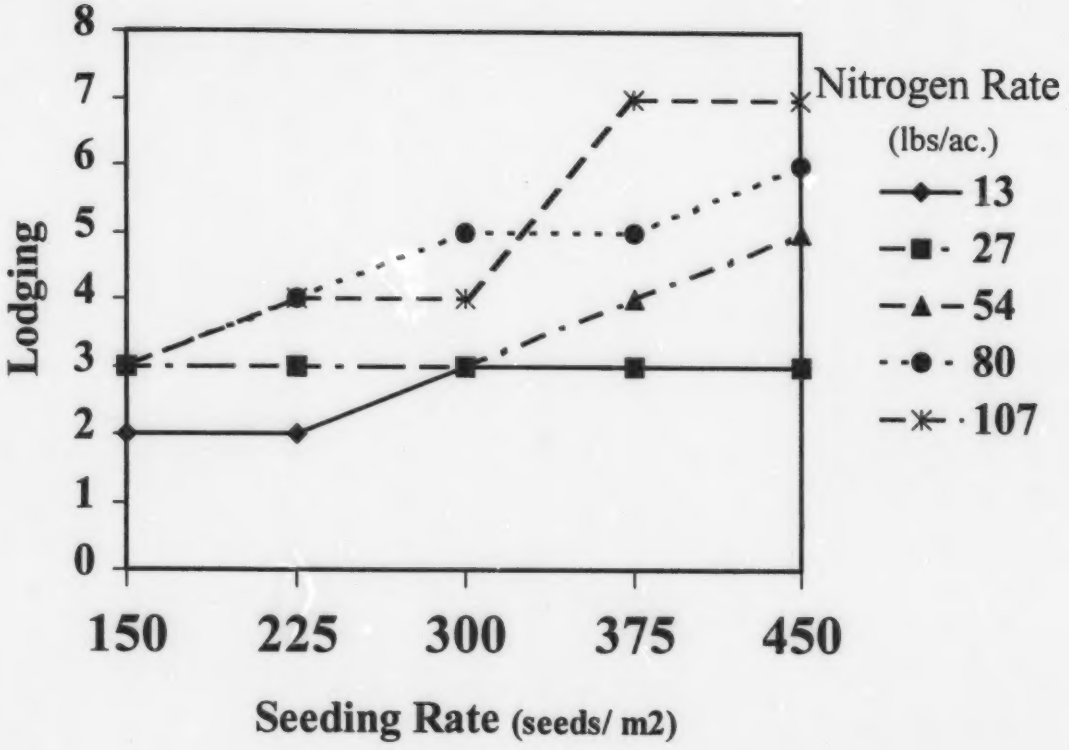

Figure 2.5 The effect of seeding rate and nitrogen on lodging of oats at Indian Head in 1999

Table 2.8 The effect of seeding rate and nitrogen rate on wild oats.

	Weyburn			Indian Head
Seeding Rate	1998	1999	2000	2000
seeds /m^2		% Wild Oats		
150	3.9*a*	2.0*a*	2.2*a*	0.79*a*
225	2.7*b*	1.6*ab*	1.4*b*	0.67*ab*
300	2.2*bc*	1.3*bc*	1.3*b*	0.30*c*
375	1.6*cd*	1.1*c*	1.0*b*	0.44*bc*
450	1.2*d*	0.9*c*	1.1*b*	0.47*bc*
Nitrogen Rate				
13	1.5*c*	1.3*a*	1.3*a*	0.40*b*
27	1.9*bc*	1.2*a*	1.2*a*	0.42*b*
54	2.6*ab*	1.5*a*	1.7*a*	0.43*b*
80	2.4*b*	1.5*a*	1.4*a*	0.74*a*
107	3.3*a*	1.4*a*	1.5*a*	0.69*a*
CV	58	53	65	61

a-d Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 2.9 The effect of seeding rate and nitrogen rate on the test weight of oats in 1998.

	Test Weight				
Seeding Rate	Indian Head	Brandon	Melfort	Canora	Weyburn
seeds /m^2			g 0.5L^{-1}		
150	244*a*	232*a*	251*a*	230	227*c*
225	243*a*	232*a*	255*a*	233	230*b*
300	245*a*	235*a*	253*a*	238	233*a*
375	247*a*	235*a*	254*a*	241	234*a*
450	248*a*	235*a*	253*a*	246	236*a*
Nitrogen Rate					
13	252*a*	233*a*	260*a*	262	238*a*
27	250*a*	235*a*	257*a*	252	236*a*
54	246*b*	236*a*	252*b*	235	232*b*
80	242*b*	233*a*	249*bc*	222	228*c*
107	237*c*	231*a*	248*c*	215	227*c*
CV	4.1	2.4	2.5	3.7	2.1

a-c Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 2.10 The effect of seeding rate and nitrogen rate on the test weight of oats in 1999.

Seeding Rate	Test Weight					
	Indian Head	Brandon		Melfort	Ituna	Weyburn
		Clay	Loam			
seeds /m^2	g 0.5L^{-1}					
150	249*a*	215*c*	241.2*c*	250*a*	245*b*	251*a*
225	246*a*	219*b*	243.6*b*	250*a*	253*a*	251*a*
300	250*a*	220*b*	244.5*ab*	249*a*	252*a*	251*a*
375	250*a*	227*a*	245.8*a*	249*a*	252*a*	253*a*
450	247*a*	229*a*	243.8*b*	251*a*	254*a*	253*a*
Nitrogen Rate						
13	260*a*	223*a*	244*a*	255*a*	263*a*	253*a*
27	253*b*	224*a*	244*a*	253*a*	260*a*	254*a*
54	248*b*	222*a*	244*a*	250*b*	249*b*	252*a*
80	241*c*	222*a*	244*a*	247*c*	244*c*	251*a*
107	238*c*	219*a*	243*a*	244*d*	240*c*	250*a*
CV	3.1	2.4	1.2	1.6	2.6	1.7

a-d Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 2.11 The effect of seeding rate and nitrogen rate on the test weight of oats in 2000.

Seeding Rate	Test Weight						
	Indian Head	Brandon		Melfort	Canora	Ituna	Weyburn
		clay loam	sandy loam				
seeds /m^2				g 0.5L^{-1}			
150	243*a*	237*a*	225.3*d*	254*a*	247*a*	250*a*	232*b*
225	243*a*	237*a*	227.9*c*	254*a*	248*a*	250*a*	234*ab*
300	246*a*	238*a*	228.4*bc*	254*a*	249*a*	252*a*	236*a*
375	245*a*	237*a*	231.4*a*	255*a*	250*a*	252*a*	235*ab*
450	243*a*	237*a*	230.6*ab*	253*a*	250*a*	250*a*	236*a*
Nitrogen Rate							
13	250*a*	243*a*	233*a*	258*a*	260*a*	257*a*	240*a*
27	249*a*	240*b*	231*a*	258*a*	256*a*	255*a*	239*a*
54	245*a*	237*c*	231*a*	253*b*	249*b*	249*b*	233*b*
80	240*c*	233*d*	227*b*	251*bc*	242*c*	247*bc*	231*bc*
107	237*d*	231*d*	223*c*	250*c*	236*d*	245*c*	230*c*
CV	2.2	1.6	1.6	1.4	2.6	1.7	1.7

a-d Values within a column for nitrogen rate or seeding rate followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

3) Nitrogen and Seeding Date

This experiment, looks at the relationships among nitrogen fertilizer rate, seeding dates, cultivars and yield. This test was conducted at Canora, Indian Head, Melfort, and Brandon in 1998 and 1999 and 2000 except there was no site at Canora in 1998. Four rates of nitrogen (15, 36, 71 and 107 lbs /acre), three seeding dates (May 1, May 15, and June1) and two cultivars, (AC Assiniboia and CDC Pacer) were used in this experiment.

Seed yield was affected by seeding date, rate of applied nitrogen and cultivar in all three years. In 1998, the early and mid May planting dates out yielded the early June planting date at Melfort (Fig. 3.1) and Indian Head (Fig. 3.2). At Brandon, the cultivars had similar grain yields except when planted in early June, in that case, the yield of CDC Pacer was 30 bushels lower than AC Assiniboia due to rust (Fig. 3.3). AC Assiniboia is resistant to most strains of rust but CDC Pacer has no resistance to crown rust. In 1999, yields from the early June planting date were closer to the first two planting dates. At Canora, the yield of CDC Pacer decreased by 20 bushels/acre from early May to early June, while the yield of AC Assiniboia did not change over the same period (Fig. 3.4). At Melfort, the yield response was similar, with the yield of CDC Pacer decreasing and AC Assiniboia increasing as planting was delayed. At Indian Head, there was very little difference among the three planting dates (data not shown). At Brandon, there was a large infestation of crown rust and very wet growing conditions in May. Under these wet conditions the yield of AC Assiniboia increased 56 bushels/acre as planting was delayed however the yield of CDC Pacer decreased 20 bushels/acre as planting was delayed due to the crown rust present in the field (Fig. 3.4). In 2000, seed yield decreased as planting was delayed at all sites with AC Assiniboia decreasing less than CDC Pacer at Indian Head and CDC Pacer decreasing less than AC Assiniboia at Melfort (Fig. 3.5).

Increasing the rate of applied nitrogen tended to increase yield, however, these yield increases were not large. In 1998, at Melfort (Fig. 3.1) and Indian Head (Figure 3.2) the early and mid May planting dates responded to nitrogen while the early June planting date did not. At Indian Head, the yield of AC Assiniboia increased up to 107 lbs per acre on early and mid May planting dates but did not respond at all on the early June planting date. The yield of CDC Pacer responded to increased rates of nitrogen up to 71 lbs per acre on the early May planting date but it did not respond at all to nitrogen on the other two seeding dates. At Melfort, the first two seeding dates responded to 107 lbs per acre while the early June seeding date increased up to 71 lbs per acre. At Brandon there was a strong response to nitrogen fertilizer up to the highest rate of 107 lbs per acre, however, all three seeding dates responded to the increasing nitrogen rate (Fig. 3.1). In 1999, the yield of AC Assiniboia at Canora and Melfort increased as nitrogen was applied up to the highest rate of 107 lbs while the yield of CDC Pacer at Canora and Melfort and both varieties at Indian Head increased up to 71 lbs of nitrogen per acre (Figure 3.6). At Brandon, there was no response to nitrogen rate. In 2000, AC Assiniboia at Melfort responded to 107 lbs per acre of nitrogen while CDC Pacer at Melfort, AC Assiniboia at the Brandon clay site and both varieties at Indian Head increased their yield up 71 lbs per acre (Fig. 3.7). The seed yield of both varieties at Canora did not increased above 36 lbs per acre, while there was a negative response to increasing the nitrogen rate at the Brandon loam site and for CDC Pacer at the Brandon clay site. The response to nitrogen appears to be larger than the response observed in the nitrogen rate by

seeding rate experiment reported in the previous section. At the moment I can not explain this, however, when the yield responded to 107 lbs per acre of nitrogen the increase from 71 to 107 was often quite low.

Test weight tended to decrease as the rate of nitrogen was increased and seeding was delayed. In 1998, the test weight decreased as seeding was delayed past mid May at all three locations(Fig 3.8). The test weight of AC Assiniboia at Melfort decreased when planting was delayed past early May. At both Melfort and Indian Head as the rate of nitrogen increased the test weight of CDC Pacer decreased, while the test weight of AC Assiniboia did not change (Fig 3.9). At Brandon, the mid May seeding date had the highest test weight and as the rate of nitrogen increased test weight decreased (Fig 3.10). The rate of nitrogen did not affect the test weight of the other two seeding dates.

In 1999, there was a small decrease in the test weight of AC Assiniboia at Indian Head when seeding was delayed past mid May while the test weight of CDC Pacer at Indain Head peaked at mid May with early May or early June seeding having a lower test weight (Fig 3.11). At Brandon, the test weight of AC Assiniboia improved as seeding was delayed and growing conditions improved, however the test weight of CDC Pacer decreased as seeding was delayed under heavy disease pressure from crown rust. At Canora, the test weight of AC Assiniboia decreased as planting was delayed but was not affected by the nitrogen rate. (Figure 3.12). On the other hand, the test weight of CDC Pacer at low rates of nitrogen was very similar at all three planting dates. But as the rate of nitrogen increased the test weight decreased and the differences between planting dates increased. At Melfort, the test weight of AC Assiniboia was not affected by the nitrogen rate while the test weight of CDC pacer decreased on all three seeding dates as the N rate increased (Fig 3.13). AC Assiniboia tended to have a lower test weight than CDC pacer at the lowest nitrogen rate. As the nitrogen rate increased this difference disappeared. At Brandon and Indian Head, the test weight decreased as the nitrogen rate increased (Fig 3.14). At Indian Head, CDC Pacer had a higher test weight than AC Assiniboia at the lowest nitrogen rate. As the nitrogen rate increased the difference disappeared and at 107 lbs per acre AC Assiniboia had a higher test weight than CDC Pacer.

In 2000, test weight declined as seeding was delayed except at Canora and AC Assiniboia on the Brandon loam (Fig 3.15). At the three locations that experienced large decreases in test weight, Indian Head, Brandon loam and Brandon clay, CDC Pacer decreased more than AC Assiniboia. When the rate of nitrogen was increased the test weight declined at all locations except Indian Head and AC Assiniboia at Melfort (Fig 3.16). At the two locations with the highest test weight, Melfort and Canora, CDC Pacer had a higher test weight than AC Assiniboia at low nitrogen levels, however, as the nitrogen rate was increased CDC Pacer's test weight decreased much more than AC Assiniboia's test weight and at the highest nitrogen rate there was no difference in test weight between the cultivars.

In conclusion, delayed seeding reduced yields especially when seeding was delayed past mid May. The response to nitrogen was not large and while the maximum yield response was sometimes found at 107 lbs per acre, the economic response is probably at 71 lbs or lower. The two cultivars, CDC Pacer and AC Assiniboia, did not always respond differently to increasing rates of nitrogen but when they did respond differently, the differences were relatively consistent. When these differences occurred CDC Pacer had a higher yield than AC Assiniboia at

low nitrogen rates. As the nitrogen rate was increased AC Assiniboia's yield would increase at a faster rate than CDC Pacer's until at the highest rate, 107 lbs per acre, AC Assiniboia had a higher yield than CDC Pacer. At the same time CDC Pacer had a higher test weight than AC Assiniboia at low levels but CDC Pacer's test weight declined much faster than AC Assiniboia's as the nitrogen rate increased. A more in-depth analysis is required to determine how and why these differences between the cultivars occurred.

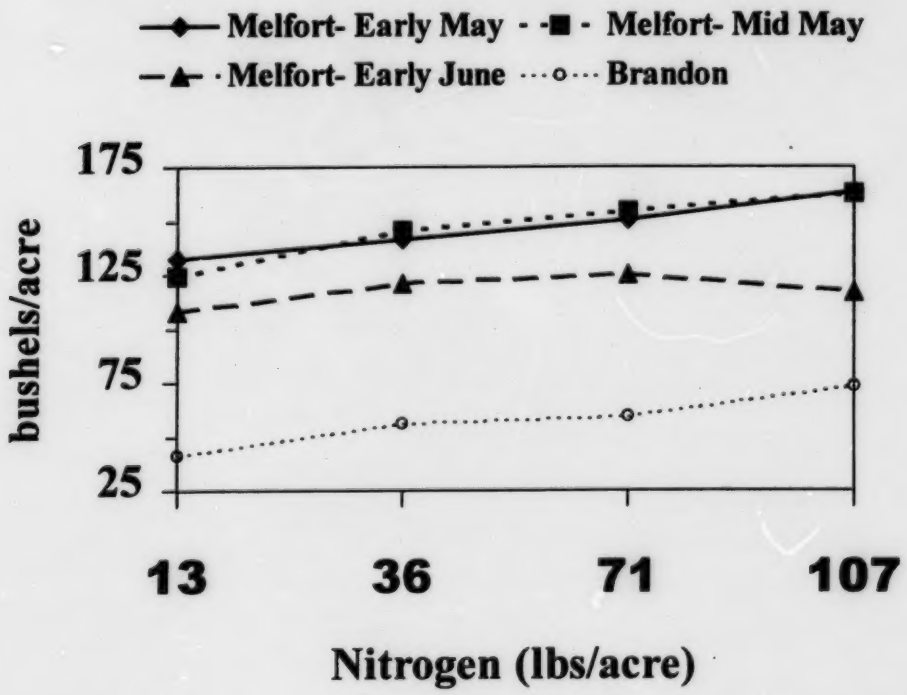

Figure 3.1 The effect of seeding date at Melfort and nitrogen rate at Melfort and Brandon in 1998.

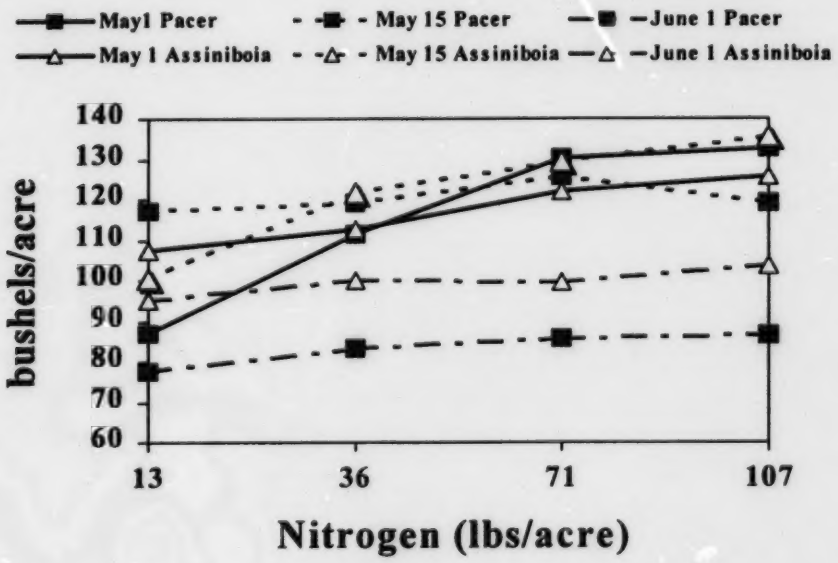

Figure 3.2. The effect of seeding date nitrogen rate and cultivar on grain yield at Indian Head in 1998.

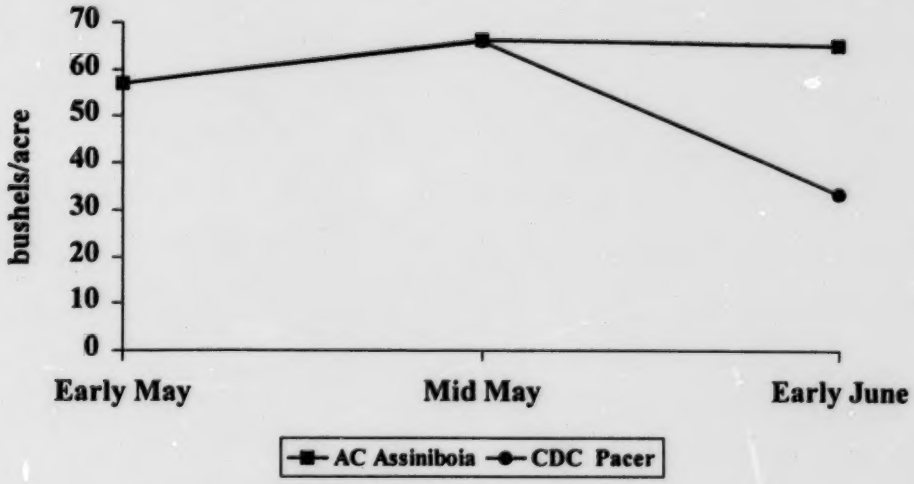

Figure 3.3 The effect of seeding date and cultivar on the yield of oats at Brandon in 1998

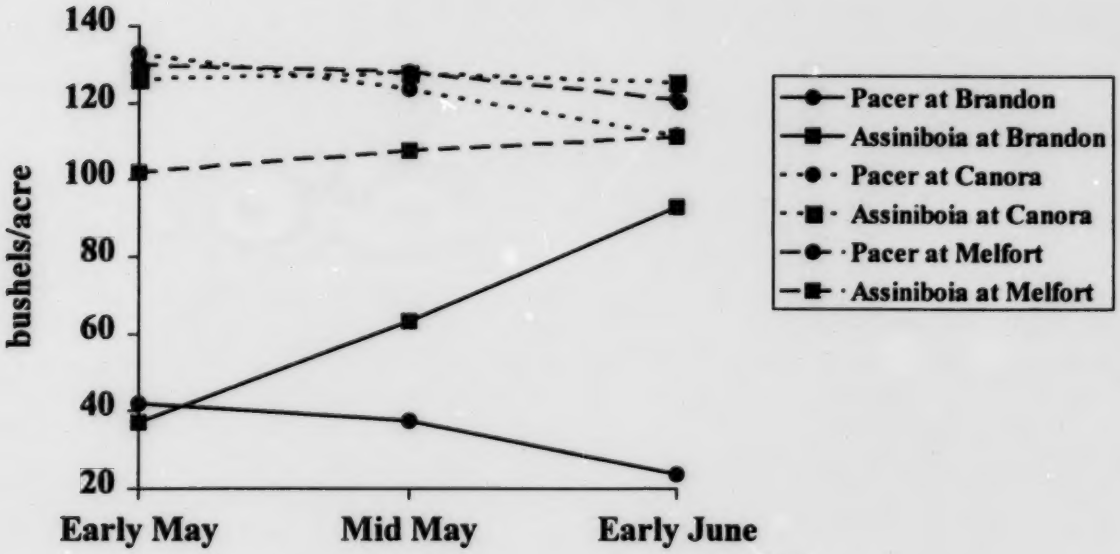

Figure 3.4 The effect of seeding date and cultivars on the yield of oats in 1999.

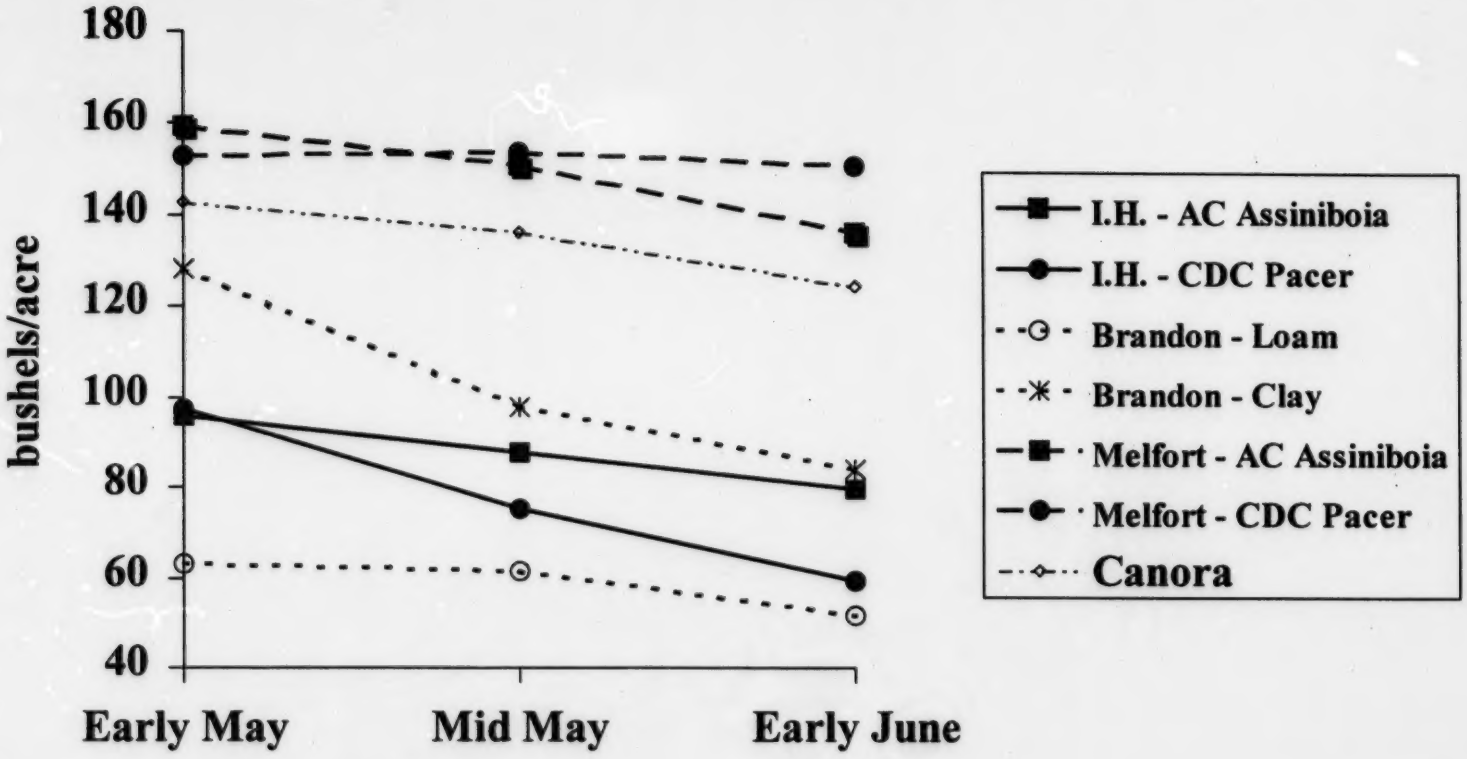

Figure 3.5 The effect of seeding date on oats in 2000

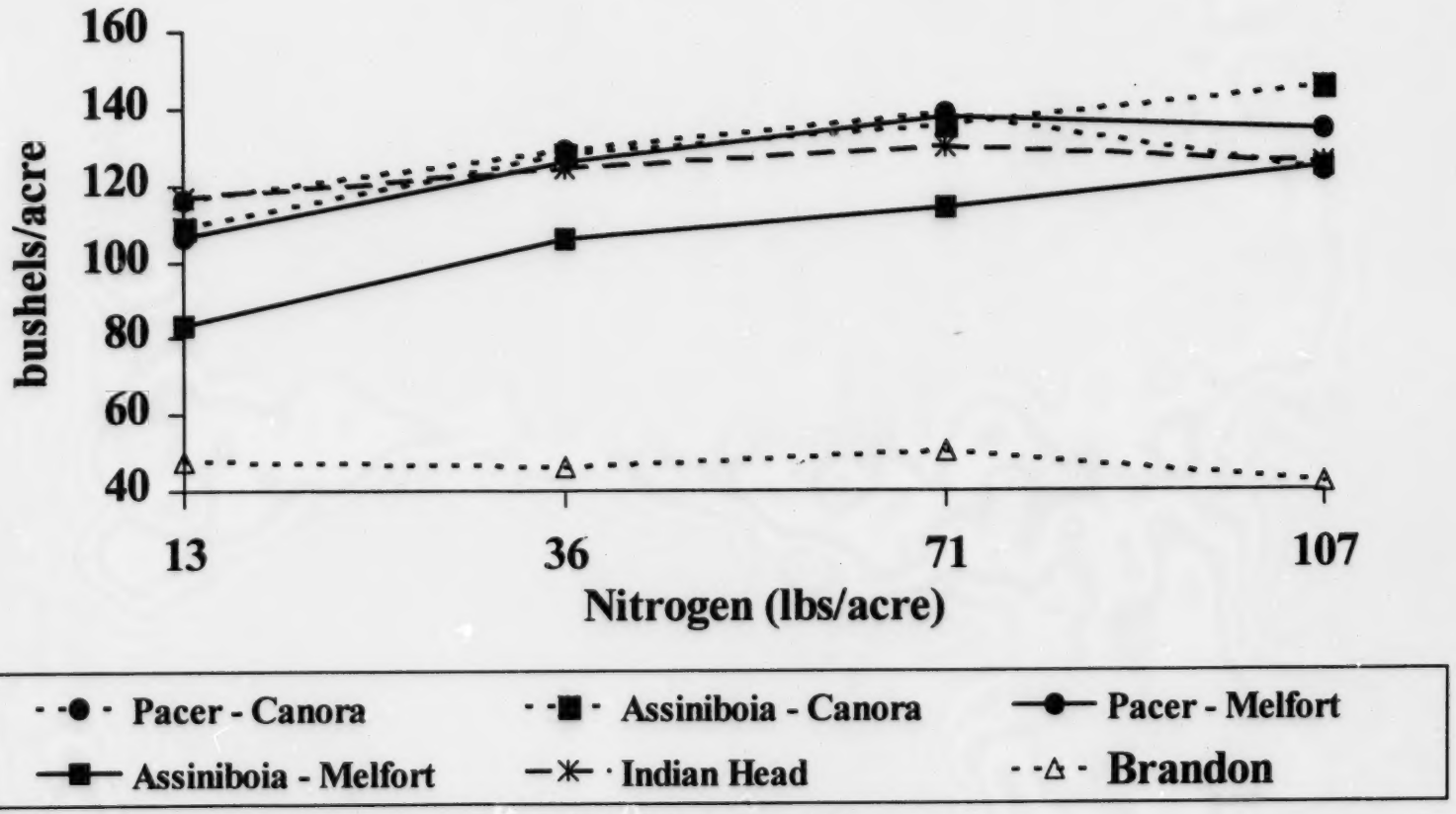

Figure 3.6 The effect of nitrogen and cultivars on the yield of oats in 1999

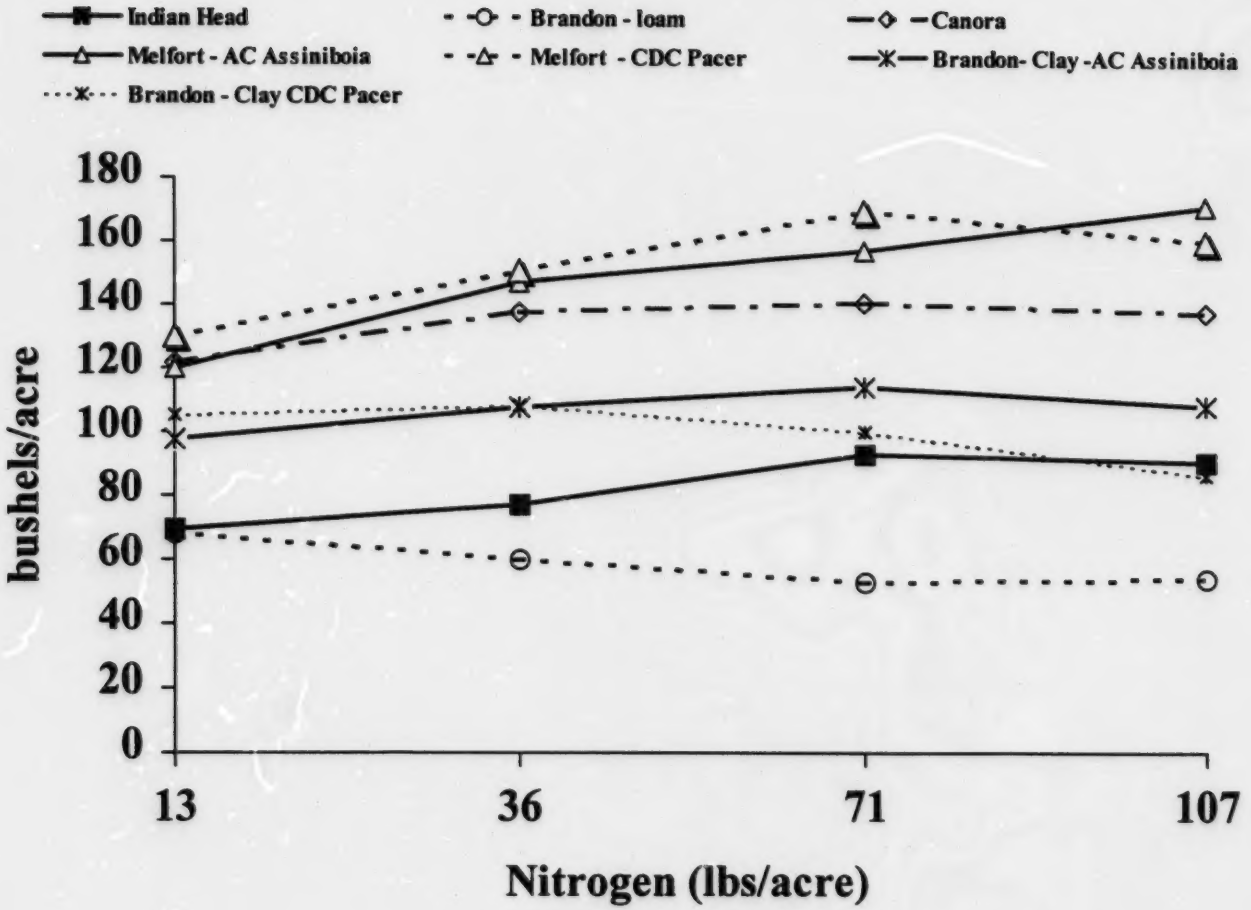

Figure 3.7 The effect of nitrogen rate on oat yield in 2000

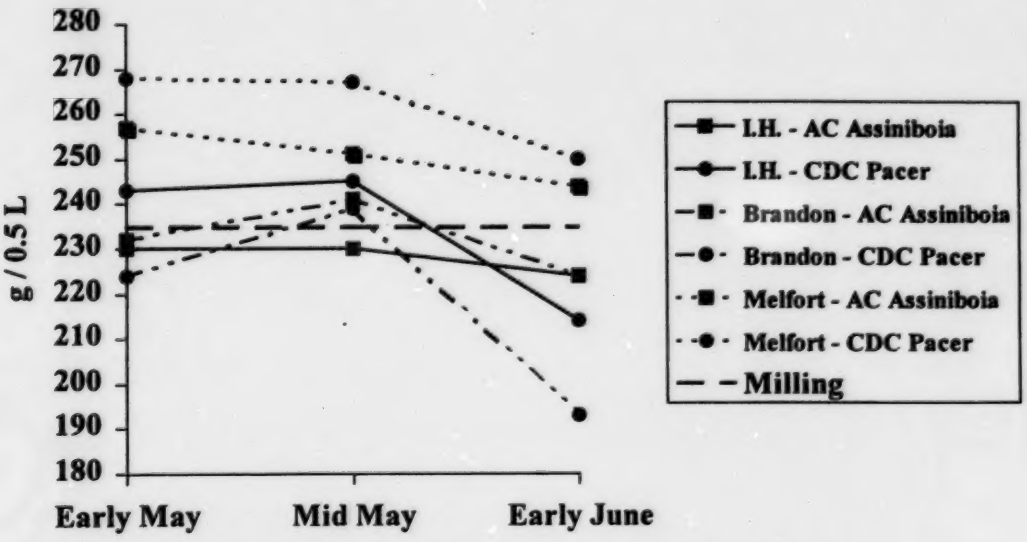

Figure 3.8 The effect of seeding date and cultivar on test weight in 1998

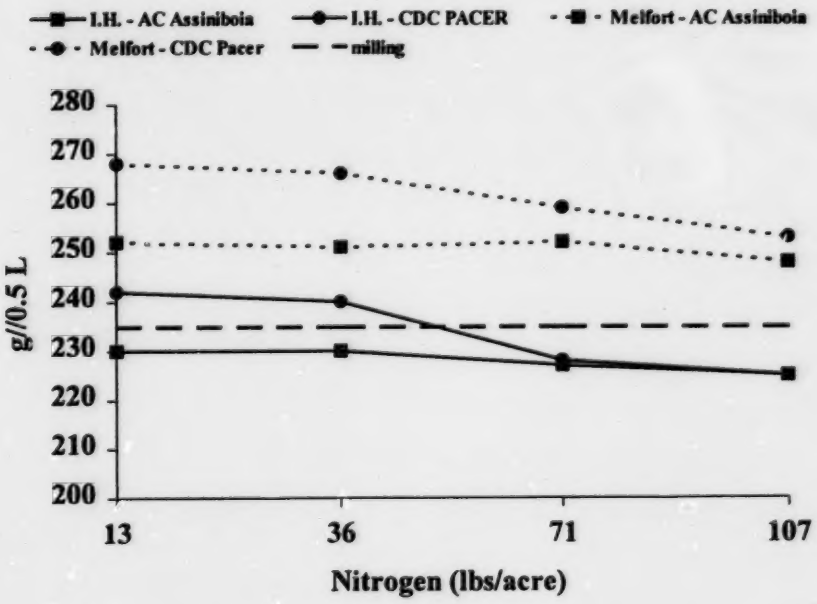

Figure 3.9 The effect of nitrogen and cultivar on test weight in 1998

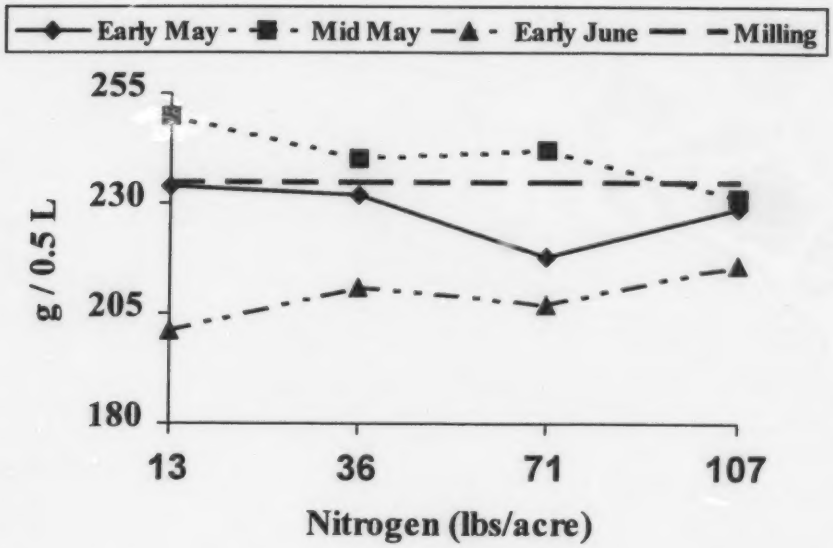

Figure 3.10 The effect of seeding date and nitrogen at Brandon in 1998

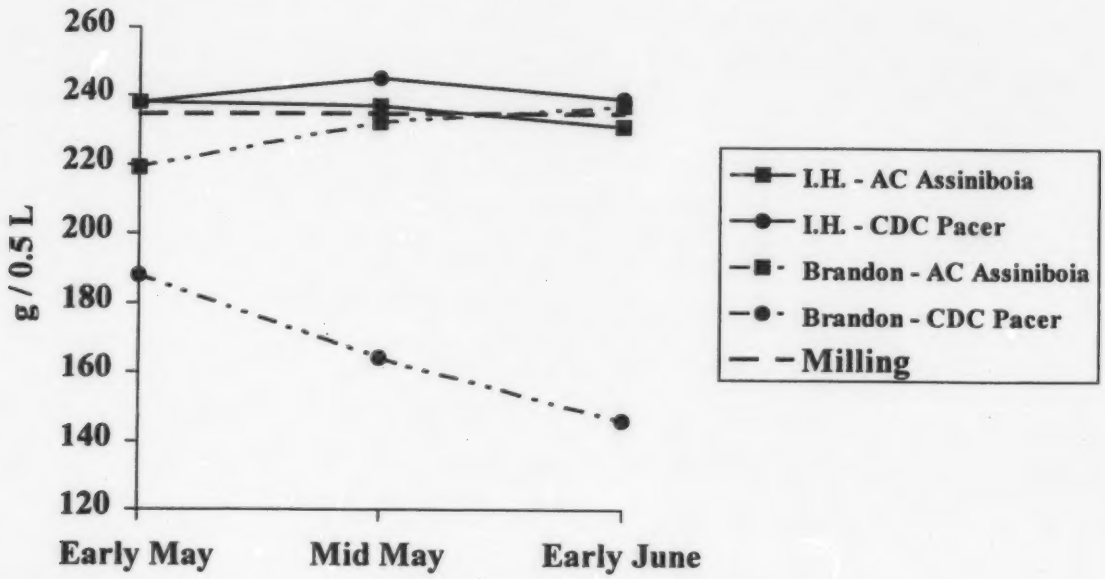

Figure 3.11 The effect of seeding date and cultivar on test weight in 1999

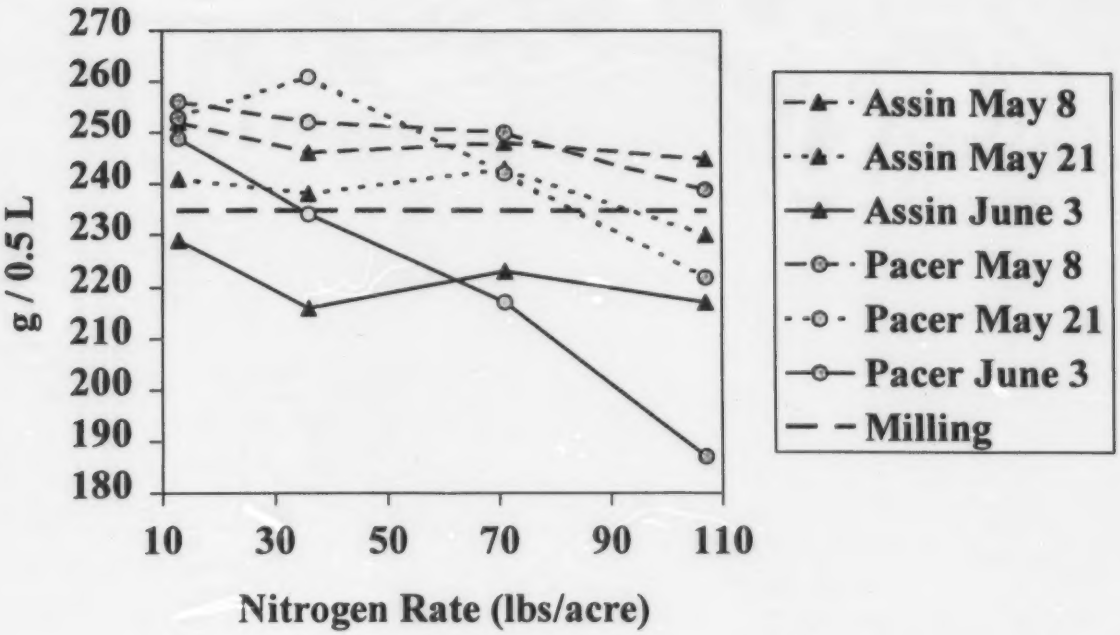

Figure 3.12 The effect of seeding date, nitrogen rate and cultivar on test weight at Canora in 1999

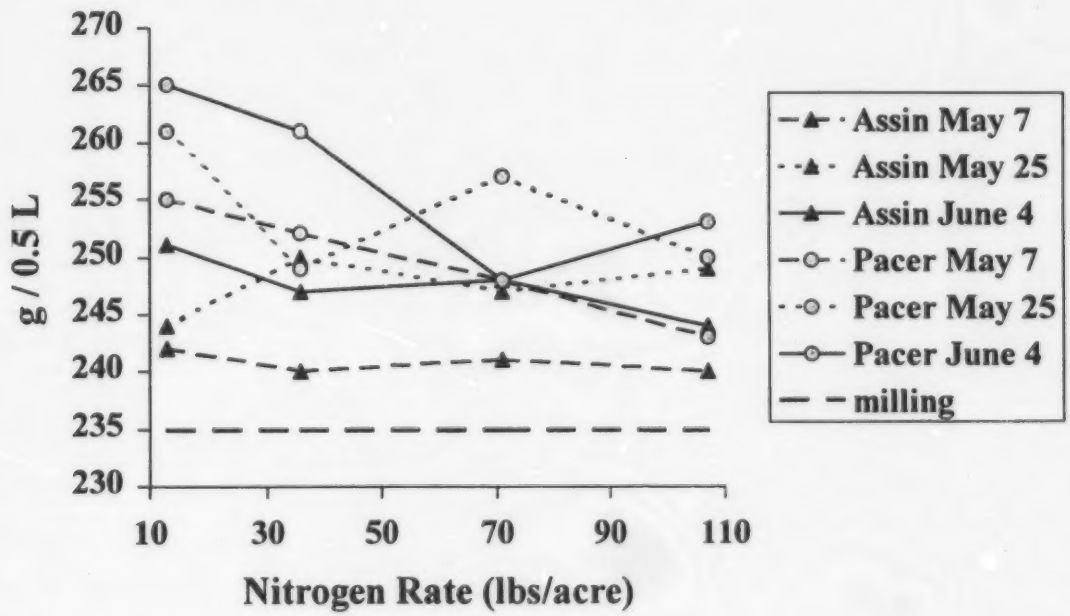

Figure 3.13 The effect of seeding date, nitrogen rate and cultivar on test weight at Melfort in 1999

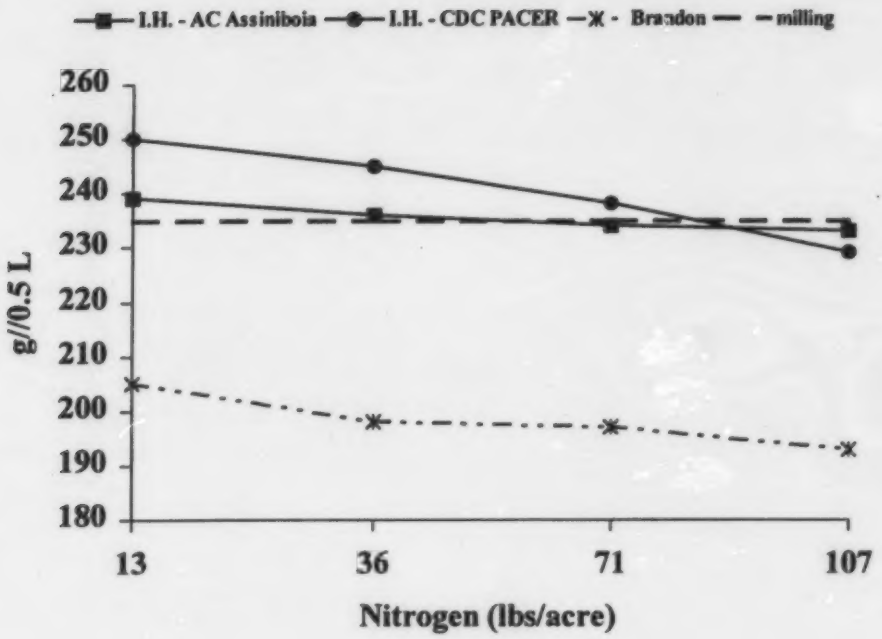

Figure 3.14 The effect of nitrogen and cultivar on test weight in 1999

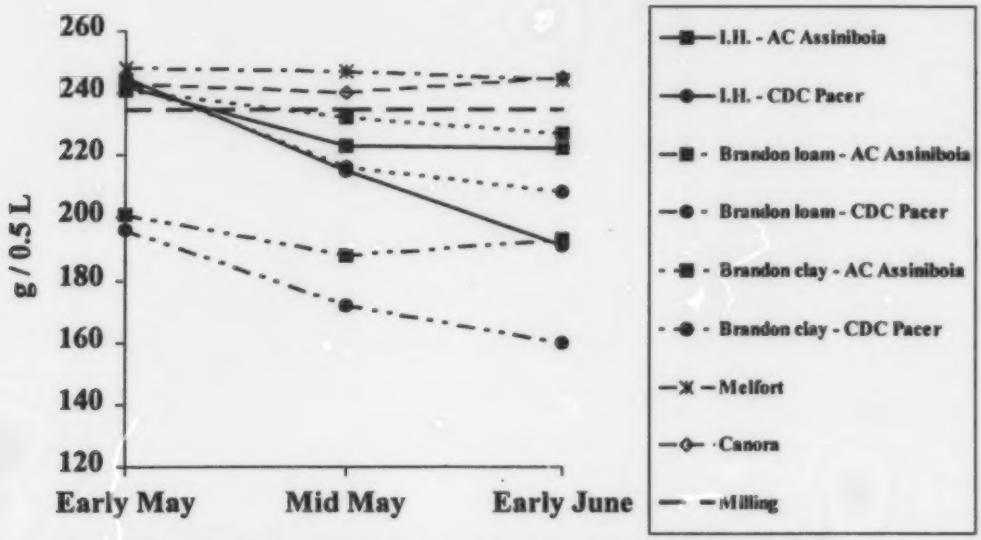

Figure 3.15 The effect of seeding date on the test weight of oats in 2000

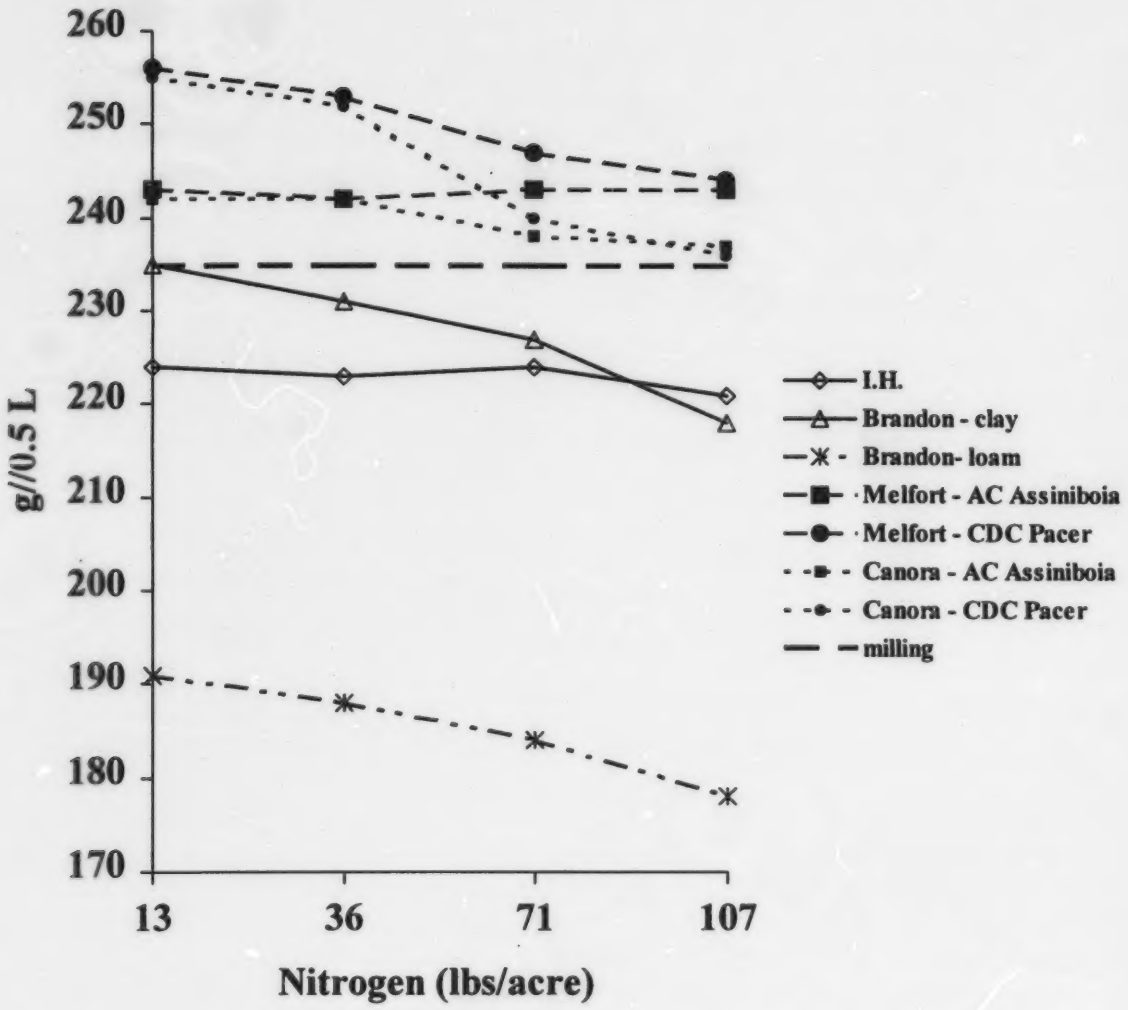

Figure 3.16 The effect of nitrogen rate on the test weight of oats in 2000

4) Swathing

Many crops in Western Canada are straight combined, however, most oats are still swathed. A large number of producers are unsure of how mature the oats should be before they are swathed. Therefore it is important to determine and demonstrate the effect of swathing at different moisture levels on yield and seed quality. In 1997, 1998, 1999 and 2000 oats were swathed when the seed moisture reached 50, 41, 32, 23 and 14 percent. This test was conducted at Indian Head in 1997 and Indian Head and Brandon in 1998,1999 and 2000. The test at Brandon was lost due to high environmental variation in 1998.

In 1997, the seed moisture at swathing affected yield, test weight, 1000 kernel weight, plump seed and thin seed. Waiting until the seed moisture reached 41% improved yield, test weight and 1000 kernel weight (Table 4.1). Waiting until the seed moisture was at 32% improved the percentage of plump seed and lowered the percentage of thin seed.

In 1998, the seed moisture at swathing affected yield, dockage, test weight, 1000 kernel weight, plump seed and thin seed (Table 4.2). Waiting until the seed moisture reached 41% reduced the percentage of dockage in the sample. Waiting until the seed moisture was at 32% improved the yield, test weight, 1000 kernel weight, percentage of plump seed and lowered the percentage of thin seed.

At Indian Head in 1999, a small yield increase occurred as swathing was delayed, with the highest yield occurring at 23% seed moisture (Table 4.3). Waiting until the seed moisture reached 41% improved test weight, seed weight, and groat yield. Waiting until the seed moisture reached 32% improved dockage, plump seed and thin seed. At Brandon in 1999, the yield increased when swathing was delayed (Table 4.4). Waiting until the seed moisture was 41% improved yield, seed weight and thin seed, while waiting until the seed moisture was 32% improved test weight, plump seed and groat yield.

At Indian Head in 2000, waiting until 41% seed moisture to swath improved yield, test weight and green count (Table 4.5). Waiting until the seed moisture reacher 32% improved plump seed, thin seed and groat yield. Dockage increased once seed moisture reached 23%. At Brandon in 2000, yield was not affected by the time of swathing (Table 4.5). Dockage, test weight, kernel weight plump seed, thin seed and groat yield all increased by waiting until seed moisture reached 41%.

For oats to be used in the milling market they need a test weight of 235g/0.5L and no more than 10% thin oats. None of the seed moisture treatments produced oats that would meet milling quality in 1997. In 1997 the oats matured very quickly suffering from drought stress. In 1998, any oats swathed at 41% seed moisture or lower met the standards for milling quality, however the best quality was reached at a seed moisture of 32% or lower. In 1999 the plots at Indian Head were under some environmental stress from heat and rust and still reached milling quality. The seed moisture level in the oats went from 41 % to 14% in 10 days. At Brandon conditions were more favourable and the oats reached milling quality. In 2000 the oats never reached milling quality at Brandon while the oats did reach milling quality at Indian Head. In most site years allowing the oats to reach 41% improved the yield and quality of the oats. In some years allowing the seed moisture to 32% resulted in a further increase in quality. I t appears that the more benign the environmental conditions the larger the benefit to delaying swathing. This data suggests that a

grower should time his swathing operations so that all his crop is below 41% seed moisture before swathing. In addition, swathing a large portion of the crop below 32 % can improve the price obtained for his oats.

Table 4.1 The effect of seed moisture at swathing on yield and seed quality in 1997

Moisture	Yield		Test Weight	Seed Weight	Plump Seed	Thin Seed
	kg/ha	bushels/acre	g/0.5L	g/1000 seeds	%	%
50%	1555*b*	40.7	175*c*	21.3*b*	5.0*c*	59.8*a*
41%	2118*a*	55.5	216*ab*	30.1*a*	18.0*b*	24.8*b*
32%	2170*a*	56.8	211*ab*	29.7*a*	22.6*a*	22.8*bc*
23%	2178*a*	57.1	220*a*	31.0*a*	24.8*a*	20.6*c*
14%	2163*a*	56.7	209*b*	30.2*a*	25.4*a*	20.0*c*
CV	7.19		3.5	3.5	12.8	9.4

a-c Values within a column followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 4.2 The effect of seed moisture at swathing on yield and seed quality in 1998 at Indian Head

Moisture	Yield (adjusted for dockage)		Dockage	Test weight	Seed Weight	Plump Seed	Thin Seed
	kg/ha	bushels/acre	%	g/0.5L	g /1000 seeds	%	%
50%	2594*c*	68	10.3*a*	204*c*	24.8*c*	47*c*	24.3*a*
41%	4251*b*	111.4	3.7*b*	244*b*	31.6*b*	76*b*	8.0*b*
32%	4650*a*	121.8	2.1*b*	255*a*	33.4*a*	88*a*	3.6*c*
23%	4679*a*	122.6	1.8*b*	258*a*	34.0*a*	87*a*	3.6*c*
14%	4452*ab*	116.6	3.4*b*	254*a*	34.3*a*	87*a*	4.2*c*
CV	4.9	4.9	417	1.4	3.4	4	32

a-c Values within a column followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 4.3 The effect of seed moisture at swathing on yield and seed quality in 1999 at Indian Head

Moisture	Yield (adjusted for dockage)		Dockage	Test weight	Seed Weight	Plump Seed	Thin Seed	Groat Yield
	kg/ha	bushels/acre	%	g/0.5L	g/1000 seeds	%	%	%
50%	3816*a*	100	10.4*a*	219*b*	3.1*b*	71.4*c*	8.8*a*	63.0*b*
41%	3973*a*	104.1	6.7*b*	239*a*	3.2*ab*	80.4*b*	5.8*b*	67.9*a*
32%	3973*a*	104.1	5.4*c*	241*a*	3.4*a*	84.3*ab*	4.1*bc*	68.5*a*
23%	4181*a*	109.5	5.4*c*	237*a*	3.3*a*	85.4*a*	3.7*c*	68.8*a*
14%	4126*a*	108.1	5.7*c*	239*a*	3.3*a*	84.5*ab*	3.8*c*	68.8*a*
Contrasts								
Linear	*		**	**	*	**	**	**
Quad	NS		**	**	0.07	**	**	**
Cubic	NS		*	**	NS	NS	NS	**
CV	5.2		9.9	2.2	4.3	3.9	26	1.1

a-c Values within a column followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 4.4 The effect of seed moisture at swathing on yield and seed quality in 1999 at Brandon

Moisture	Yield (adjusted for dockage)		Dockage	Lodging	Test weight	Seed Weight	Plump Seed	Thin Seed	Groat Yield
	kg/ha	bushels/acre	%	(1-9)	g/0.5L	g/1000 seeds	%	%	%
50%	2739*b*	71.7	11.4*a*	1.0*a*	228*c*	3.72*b*	73*c*	2.9*b*	62.9*c*
41%	3537*a*	92.7	7.5*b*	1.2*a*	241*b*	4.2*a*	88*b*	2.8*b*	68.3*b*
32%	3830*a*	100.3	5.5*bc*	1.4*a*	245*ab*	4.3*a*	91*ab*	2.8*b*	70.9*a*
23%	3628*a*	95	5.1*bc*	1.2*a*	248*a*	4.3*a*	91*ab*	4.4*b*	71.2*a*
14%	3783*a*	99.1	7.9*c*	1.0*a*	246*ab*	4.3*a*	92*a*	10.6*a*	71.8*a*
Contrasts									
Linear	**		**	NS	**	**	**	**	**
Quad	**		*	0.07	**	**	**	**	**
Cubic	0.07		NS	NS	NS	*	**	*	NS
CV	8.9		28	32	1.6	3.1	3.2	30	2.4

a-c Values within a column followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 4.5 The effect of seed moisture during swathing on yield and seed quality in 2000 at Indian Head (00611)

Moisture	Yield (adjusted for dockage)		Dockage	Test weight	1000 Kernel Weight	Plump Seed	Thin Seed	Groat Yield	Green
	kg ha^{-1}	bushels $acre^{-1}$	%	g $0.5L^{-1}$	g 1000 $seeds^{-1}$	%	%	%	
50%	3168*b*	83.0	3.4*c*	224*c*	62.3*a*	81*c*	5.2*a*	55.6*c*	10.6*a*
41%	3972*a*	104.0	3.6*c*	234*ab*	60.8*a*	92*b*	2.0*b*	56.4*bc*	6.8*b*
32%	4028*a*	105.5	3.7*c*	238*a*	60.1*a*	94*ab*	1.4*c*	58.5*ab*	7.2*b*
23%	4266*a*	111.7	6.2*b*	236*a*	60.4*a*	95*a*	1.0*c*	59.4*a*	5.2*b*
14%	4219*a*	110.5	9.4*a*	233*b*	61.2*a*	95*a*	1.5*bc*	58.4*ab*	5.4*b*
Contrasts									
Linear	**		**	**	NS	**	**	**	**
Quad	*		**	**	NS	**	**	NS	NS
Cubic	NS		NS	NS	NS	**	0.07	NS	NS
CV	9.3		25	1.7	5.1	1.9	30	3.3	35

Table 4.6 The effect of seed moisture during swathing on yield and seed quality in 2000 at Brandon (00612)

Moisture	Yield (adjusted for dockage)		Dockage	Test weight	1000 Kernel Weight	Plump Seed	Thin Seed	Groat Yield	Green
	kg ha^{-1}	bushels $acre^{-1}$	%	g $0.5L^{-1}$	g 1000 $seeds^{-1}$	%	%	%	
50%	2198*a*	57.6*a*	14.3*a*	154*b*	46.1*b*	76*b*	7.8*a*	34.2*b*	33.6*a*
41%	3409*a*	89.3*a*	6.9*b*	194*a*	55.5*a*	90*a*	2.4*b*	42.7*a*	15.4*a*
32%	2744*a*	71.9*a*	9.0*b*	183*a*	53.2*a*	84*ab*	4.8*ab*	40.1*a*	21.2*a*
23%	3384*a*	88.7*a*	7.6*b*	188*a*	52.3*a*	88*a*	3.1*b*	43.0*a*	27.2*a*
14%	3303*a*	86.5*a*	7.4*b*	197*a*	56.1*a*	88*a*	3.4*b*	43.8*a*	18.0a
Contrasts									
Linear	0.06		*	**	**	*	**	**	NS
Quad	NS		0.07	*	NS	NS	0.08	NS	NS
Cubic	NS		0.09	**	**	0.09	NS	NS	*
CV	24		37	6.7	7.2	7.6	55	11	42

5) Swathing vs Straight Combining

Shattering of the oats as the crop ripens is one of the major reasons that oats are swathed instead of straight combined. Work conducted at Swift Current suggested that there were differences among cultivars for shattering. We do not have any information on the tendency of cultivars currently grown to shatter. If growers know that certain cultivars are not prone to shattering they may be inclined to grow that variety and direct combine the oats to get the highest possible grade and eliminate swathing costs. In 1998 and 1999 the adaptability of eight cultivars to combining the standing crop were compared at Indian Head and Brandon and at Indian Head in 2000. At Brandon in 2000, three rust susceptible cultivars were dropped, AC Juniper, CDC Pacer and Derby and replaced with two rust resistant varieties, AC Pinnacle and OT 298. Combining of the standing crop will be call straight combining for the rest of this section.

The yields achieved from Straight combining were similar to the yields obtained when the crop was swathed and then combined at both locations and both years (Table 5.1). There was a significant interaction between cultivars and harvest method at Brandon in 1999. The yield of the semi dwarf was significantly lower when swathed instead of straight combined. There were significant differences in yield among the cultivars. The largest differences occurred when crown rust infected a significant amount of leaf tissue. This occurred at Indian Head in 1999 and at Brandon in both years. AC Assiniboia and the Semi Dwarf line had the lowest susceptibility to the Crown rust races present at these locations. Triple Crown is less resistant than AC Assiniboia and the Semi Dwarf line but more resistant than CDC Boyer. CDC Boyer and AC Preakness have a small amount of resistance while Derby, CDC Pacer and AC Juniper have none. The yields at Brandon and Indian Head in 1999 for these cultivars reflect the amount

of resistance they have to crown rust.

The harvesting treatments had no consistent effect on dockage. At Indian Head, there were no differences between the harvesting methods in 1998 and 1999. At Brandon the swath and combine harvesting system had lower dockage than straight combining in 1998 but higher dockage in 1999 and 2000 (Table 5.2). Also, at Indian Head in 2000 the swath and combine method had a higher level of dockage than straight combining. It appears that at Brandon in 1999 the rust susceptible cultivars lodged and when the swaths were combined extra material (soil) was picked up. The cultivars susceptibility to rust affected dockage at Brandon in 1998 and both locations in 1999 and 2000. The susceptible cultivars had higher levels of dockage in the presence of crown rust. It would be interesting to see if these results would be changed if large field scale plots were used over different landscapes.

Test weight was not affected by the harvesting treatments at Indian Head (Table 5.2). At Brandon, the straight combining treatment had a significantly higher test weight in 1998 while in 1999 AC Juniper and Triple Crown had higher test weight relative to the other cultivars when swathed instead of straight combined and there were no differences between the two harvesting methods in 2000.

Lodging was measured for the straight combine treatments and in 1999 at Brandon the lodging was also measured for the swathed treatments. The semi dwarf line had consistently low levels of lodging (Table 5.3). At Indian Head in 1998 the semi dwarf line had more lodging than was observed in 1999 and 2000 at Indian Head or at Brandon in all years. In 1998 at Indian Head, we had a higher level of wild oats and when the wild oats lodged they lodged the semi dwarf. This indicates that in fields with a moderate number of wild oats a semi dwarf oat cultivar may

lodge more than expected. AC Assiniboia and Triple Crown on average had more lodging than the semi dwarf but less than the other cultivars. As expected, when lodging between the two harvest methods was measure at Brandon in 1999, the lodging of the cultivars increased when the crop was allowed to mature standing instead of in the swath. The increase was not large.

One of the biggest concerns growers have about straight combining is the amount of shattered seed. To measure this problem we measured the amount of seed that shattered out of the panicle and fell to the ground. In addition we measured the amount of seed which fell to the ground as broken panicles. The cultivars differed in shattering only in 1998 at Indian Head (Table 5.3). There was no statistical difference in the % of seed found in broken panicles except in 2000 when AC Juniper had more lodged broken panicles than the other cultivars. Both shattered seed and broken panicles need to be measured since a cultivar which lodges or has panicle breakage in high winds will probably not have a lot of shattering. In 1999 at Indian Head, we had our largest differences in shattering even though the differences were not statistically significant. In 1999 the plots were planted on June 1st and the summer was cool and wet. The crop did not start to mature until September and the rust resistant cultivars took until October for the straw to dry enough for combining. The cultivars that were susceptible to crown rust were desiccated by the crown rust and were harvested in September.

The semi dwarfs lodge less than cultivars of normal height. However in oats my major concern with semi dwarfs is their ability to compete with wild oats since there is no way to control wild oats in oats with herbicides. Wild oats were present in the plots at Indian Head in 1998 and 1999 (Table 5.4). In both years the semi dwarf had more wild oats in the harvested sample than the other cultivars. The harvesting method did not affect the amount of wild oats in the sample.

Straight combing of oats is a practical harvest method for oats under certain conditions. Straight combing will be more successful when oats are grown on fairly uniform land and the planting date is early enough to allow the oats to ripen in August. The semi dwarf line, AC Assiniboia and Triple Crown are varieties that will perform well in a straight combining system if they mature before September. AC Juniper is not a suitable variety for straight combining and at present there is not enough data on the rust susceptible cultivars grown in the absence of Crown rust to confidently identify suitable cultivars.

Table 5.1 The effect of harvest method and cultivar on the yield of oats

	Indian Head			Brandon			
	1998	1999	2000	1998	1999		2000
	bushels/acre						
Straight Combined	112.1*a*	97.6*a*	91.1*b*	41.2*a*			65.3*a*
Swathed	113.1*a*	100.8*a*	97.0*a*	45.8*a*			78.9*a*
Cultivar					Straight	Swathed	
AC Assiniboia	112.5*abc*	122.1*ab*	108.4*a*	87.1*a*	103.8*a*	98.8*a*	79.4*c*
AC Juniper	106.2*c*	79.6*d*	89.1*c*	14.6*d*	7.6*e*	11.9*e*	-
AC Preakness	119.9*a*	88.1*cd*	97.4*b*	20.8*d*	26.9*c*	24.1*d*	35.3*e*
CDC Boyer	104.2*c*	94.2*c*	98.3b	37.0*c*	48.8*b*	48.4*c*	50.4*d*
CDC Pacer	118.9*a*	81.8*d*	83.0*c*	23.5*d*	16.7*d*	22.0*d*	-
Derby	115.3*ab*	79.6*d*	82.6*c*	23.1*d*	19.1*cd*	26.0*d*	-
Semi Dwarf	107.8bc	131.5*a*	86.0*c*	79.8*a*	105.1*a*	86.1*b*	111.8*a*
Triple Crown	115.7*ab*	117.6*b*	107.5*a*	62.3*b*	55.5*b*	57.1*c*	45.6*de*
AC Pinnacle							93.9*b*
OT 298							88.1*bc*
CV	7.6	11.0	8.3	24.0	13		16

a-f Values within a column for harvest method or cultivar followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

Table 5.2 The effect of harvest method and cultivar on the dockage, test weight and in a harvested sample of oats

	Dockage (%)						Test weight (g/0.5L)					
	Indian Head			Brandon			Indian Head			Brandon		
	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000
Straight Combined	2.7*a*	7.8*a*	4.5*b*	8.8*a*		7.5*b*	239*a*	196*a*	222*a*	172*a*		194*a*
Swathed	3.0*a*	7.8*a*	5.1*a*	6.5*b*		9.1*a*	239*a*	199*a*	223*a*	165*b*		194*a*
Cultivar					Straight Swathed						Straight Swathed	
AC Assiniboia	3.3*ab*	3.4*c*	2.6*f*	4.3*b*	2.2*b* 5.1*de*	6.2*bc*	232*e*	221*b*	224*b*	220*a*	241*a* 236*a*	211*a*
AC Juniper	3.9*a*	11.8*c*	9.3*a*	7.3*ab*	9.5*a* 19.5*b*	NA	244*b*	168*e*	213*d*	129*d*	144*e* 184*c*	
AC Preakness	2.6*bc*	8.8*b*	5.2*bc*	9.8*a*	6.2*ab* 20.6*b*	10.8*a*	235*ed*	192*c*	226*ab*	169*b*	212*b* 211*b*	180*b*
CDC Boyer	2.8*bc*	7.7*b*	4.0*cde*	7.8*a*	8.0*ab* 11.9*cd*	10.8*a*	231*e*	196*c*	218*c*	171*b*	200*bc* 205*b*	184*b*
CDC Pacer	2.0*c*	11.5*a*	6.3*b*	10.0*a*	9.2*a* 27.8*a*	NA	243*cb*	175*de*	219*c*	132*cd*	144*e* 167*d*	NA
Derby	1.8*c*	10.9*a*	4.4*cd*	8.3*a*	7.2*ab* 18.8*bc*	NA	249*a*	181*d*	230*a*	138*c*	176*d* 187*c*	NA
Semi Dwarf	4.0*a*	3.3*c*	3.8*def*	4.3*b*	1.9*b* 3.9*e*	6.2*bc*	238*cd*	232*a*	224*b*	217*a*	241*a* 240*a*	210*a*
Triple Crown	2.4*bc*	5.0*c*	2.9*ef*	9.5*a*	5.7*ab* 10.5*de*	11.0*a*	242*bc*	217*b*	224*b*	171*b*	194*c* 200*b*	145*c*
AC Pinnacle						5.3*c*						214*a*
OT 298						6.4*bc*						214*a*
CV	38	21.0	25	42	47	21	1.9	5.1	1.9	5.2	4.5	4.8

a-e Values within a column for harvest method or cultivar followed by the same letter are not different at $P \leq 0.05$ by protected LSD. NA - Not available

Table 5.3 The effect of harvest method and cultivar on the lodging and shattering of oats

	Lodging (1-9)							Shattered seed (%)						Broken Panicles (%)		
	Indian Head			Brandon				Indian Head			Brandon			Indian Head		
	1998	1999	2000	1998	1999		2000	1998	1999	2000	1998	1999	2000	1998	1999	2000
Cultivar					Straight	Swathed										
AC Assiniboia	4.3*bc*	5.0*de*	3.5*e*	1.3*b*	2.8*f*	1.8*f*	7.5*ab*	2.3*bc*	8.3*a*	5.4*a*	0.1*a*	0.7*a*	2.3*a*	4.3*a*	1.4*a*	5.2*b*
AC Juniper	6.8*a*	5.3*cde*	4.1*de*	4.0*a*	9.0*a*	9.0*a*	NA	3.2*bc*	2.1*a*	8.7*a*	0.8*a*	0.1*a*	NA	8.5*a*	7.0*a*	10.7*a*
AC Preakness	4.5*bc*	7.4*ab*	6.8*a*	4.0*a*	5.8*c*	4.5*d*	7.4*ab*	1.7*bc*	6.1*a*	4.6*a*	0.6*a*	1.0*a*	3.4*a*	4.8*a*	2.9*a*	5.3*b*
CDC Boyer	6.0*a*	7.5*a*	5.0*c*	3.8*a*	3.8*e*	1.0*f*	7.8*ab*	3.4*b*	2.6*a*	6.5*a*	1.3*a*	1.1*a*	2.6*a*	4.5*a*	1.8*a*	6.0*b*
CDC Pacer	5.5*ab*	6.0*bcd*	6.0*b*	4.0*a*	8.0*b*	7.5*b*	NA	4.1*ab*	1.2*a*	3.3*a*	0.3*a*	1.3*a*	NA	4.5*a*	4.8*a*	5.0*b*
Derby	4.5*bc*	6.6*abc*	4.5*cd*	4.0*a*	7.3*b*	6.3*c*	NA	5.9*a*	1.7*a*	9.0*a*	0.6*a*	1.8*a*	NA	5.1*a*	2.1*a*	6.1*b*
Semi Dwarf	3.5*cd*	1.1*f*	1.0*g*	1.3*b*	1.0*g*	1.0*f*	2.0*d*	0.8*c*	2.4*a*	1.4*a*	0.2*a*	0.2*a*	1.6*a*	5.8*a*	4.9*a*	2.1*b*
Triple Crown	2.5*d*	4.4*e*	2.5*f*	3.5*a*	4.3e	2.3*e*	5.3*c*	3.0*bc*	11.6*a*	6.5*a*	0.4*a*	1.7*a*	1.5*a*	3.9*a*	2.8*a*	2.3*b*
AC Pinnacle							8.1*a*						2.7*a*			
OT 298							6.3*bc*						2.2*a*			
CV	22	26.0	16	12	14		24	51	109	65	107	103	48	63	88	49

a-f Values within a column for harvest method or cultivar followed by the same letter are not different at $P \leq 0.05$ by protected LSD. NA - Not available

Table 5.4 The effect of harvest method and cultivar on the dockage, test weight and wild oats in a harvested sample of oats

	Wild Oats (%)	
	Indian Head	
	1998	1999
Straight Combined	1.1*a*	0.4*a*
Swathed	1.1*a*	0.4*a*
Cultivar		
AC Assiniboia	1.1*b*	0.3*b*
AC Juniper	1.3*b*	0.4*b*
AC Preakness	0.9*b*	0.3*b*
CDC Boyer	1.1*b*	0.3*b*
CDC Pacer	0.7*b*	0.4*b*
Derby	0.7*b*	0.3*b*
Semi Dwarf	2.5*a*	0.8*a*
Triple Crown	0.5*b*	0.2*b*
CV	93	81

a-e Values within a column for harvest method or cultivar followed by the same letter are not different at $P \leq 0.05$ by protected LSD.

PERSONAL

Orla Willoughby
Chris Omoth
Steve Kopp
Orla Willoughby
Chris Willinburg
Chris Hozapfel
Glen Davidson
Maddie Horseman

PROJECT DEVELOPED MATERIALS

No materials have yet been developed except for slides and overheads used to present data.

PROJECT ACTIVITIES

Information on this project has been disseminated in the following ways.

(3) Field Days and Tours

(1) Zero Till Field Day, Indian Head, July 1998
(2) Brandon Field Day, July 1998
(3) Melfort Field Day, July 1998
(4) Tour organized by Prairie Oat Growers Association (POGA), July 1998
(5) Canora Field Day, July 1998
(6) Zero Till Field Day, Indian Head, July 1999
(7) Brandon Field Day, July 1999
(8) Canora Field Day, July 1999
(9) Tour for Prairie Oat Growers Association (POGA), July 1999
(10) Zero Till Field Day, Indian Head, July 2000
(11) Brandon Field Day, July 2000
(12) Canora Field Day, July 2000

(4) Presentations

(1) New Research in oat and canary research, Indian Head Agricultural Research Foundation's Winter Meeting, Indian Head, January 1998
(2) Oat Agronomy - optimizing yield and quality in the future, 5th Annual Regional Agricultural Conference, Kipling, March 1998
(3) Oat Agronomy - optimizing yield and quality, POGA First Annual Meeting, Saskatoon, December 1998
(4) Indian Head Agricultural Research Foundation's Winter Meeting, Indian Head,

January 1999

(5) Crop Update 1999, Saskatchewan Agriculture and Agri-Food, March 10th at Fort Qu'Appelle, SK and on March 11th at Broadview, SK,

(6) Update on Oat Agronomy in Western Canada. Western Canadian Agronomy Workshops, Brandon, MB, July 1999

(7) Oat Agronomy - optimizing yield and quality, POGA Second Annual Meeting, Saskatoon, December, 1999

(8) Presentation to SAF AG.REps in Saskatoon, December, 1999

(9) Impact of nitrogen fertilization and seeding rate on oats. 43rd Annual Meeting of the Manitoba Society of Soil Science (MSSS) in Winnipeg, January 25-26, 2000

(10) Seeding dates and nitrogen rates in oats. Indian Head Agricultural Research Foundation's Winter Meeting, Indian Head, January 2000.

(11) The impact of seeding date on the yield and quality of oats. Soils and Crops 2000, Saskatoon, SK, Feb 24-25, 2000.

(12) Oat and Canaryseed: Low Input Crops. Crops Farm Update - 2000 and Beyond, Weyburn, March 14, 2000

(13) Oat Agronomy. Grower meeting, Yorkton, March 16, 2000

(14) Oat Agronomy. Grower meeting, Windthorst, April 12, 2000

(15) The impact of seeding date on the yield and quality of oats. Pages 376-384 in In Proceedings of the Soils and crops Workshop, University of Saskatchewan, Saskatoon, SK, Feb 24th and 25th , 2000.

(16) Oat Quality and Yield: Effects of seeding date and nitrogen fertilization in Western Canada. Agronomy Abstracts. American Society of Agronomy Annual Meetings. November, 2000. Minneapolis.

(17) Oat Yield and Quality: Effects of nitrogen fertilization and seeding rate (Abstr). Sixth International Oat Conference, Lincoln University, New Zealand. December 2000.

(18) Optimizing Oat Production. Grower meeting, Balcarres, January 17, 2001

(19) Optimizing Oat Production. Indian Head Agricultural Research Foundation's Winter Meeting, Indian Head, January 2001.

(20) Managing Oats for Yield and Quality. P. 97-103. 23rd Annual Manitoba-North Dakota Zero Tillage Workshop. January 8-10, 2001. Brandon, MB.

(21) Maximizing oat yield and quality. Manitoba Zero Tillage Research Association Annual Research Day and General Meeting. February 7, 2001. Brandon, MB.

(22) Oat yield and quality: Effects of nitrogen fertilization and seeding rate. Manitoba Soil Science Society Meetings. January 23-24, 2001. Winnipeg, MB.

(23) Oat Yield and Quality: Effects of Seeding Date. Displayed at the 23rd Annual Manitoba-North Dakota Zero Tillage Workshop. January 8-10, 2001. Brandon, MB.

(24) Oat Yield and Quality: Effects of Nitrogen Fertilization and Seeding Rate. Displayed at the 23rd Annual Manitoba-North Dakota Zero Tillage Workshop. January 8-10, 2001. Brandon, MB.

(25) Optimizing Oat Production. Grower meeting, Redvers, March 7, 2001

(26) Optimizing Oat Production. Grower meeting, Grenfell, March 20, 2001

(27) Optimizing Oat Production. Grower meeting, Redvers, March 27, 2001
(28) Optimizing Oat Production. Grower meeting, Redvers, April 26, 2001

(5) Written Articles

(1) Oat Research Report, Indian Head Agricultural Research Foundation's Newsletter, March 1998
(2) Demand High for New Oat Production Research, Press Release, April 1998
(3) Western Canadian oats prized by millers, Top Crop Manager, April 1998
(4) New Study Targets Oat Production, News Notes, AAFC, Pub. No. 185, May 11,1998
(5) Oats Revisited, Farm Tek Advances, June 1998
(6) Optimizing oat production, Prairie Oat Growers Association's Newsletter, June 1998
(7) Dollars for research, Indian Head Agricultural Research Foundation's Newsletter, June 1998
(8) Boning up on growing oats, CSGA Seed Scope, September 1998
(9) Oat Farmers Getting home-grown research, Western Producer, September 17, 1998
(10) Television interview with CK CTV which aired in July
(11) Oat Agronomy: seeding date, Indian Head Agricultural Research Foundation's Newsletter, December 1998
(12) Seed oats early to boost yield big time, Grain News, January 1999
(13) Nitrogen rate, seeding date and oat yields. Indian Head Agricultural Research Foundation's Newsletter, March 2000. pp 6-7.
(14) Nitrogen rate, seeding date and oat yields. East Cental Research Foundation's Newsletter, Spring 2000.
(15) Oats take off with a few adjustments. Country Guide, Wheat Oats & Barley Guide. March 2000. pp10-12.
(16) Research shows oats pay $1.23 for each $1 of N. Grain News, April 2000, Vol 26. No. 9, pg 34
(17) Oats Coming Back. The Oat Scoop July, 2000, Vol 2 (2) pgs 7-9.
(18) Managing oats to optimize yield and quality. January 15, 2001. P. 5 in The Agri Times.
(19) Oats yield more when planted early. By Ian Bell. January 4, 2001. P. 50 in The Western Producer.
(20) Seed oats early for big yield. Top Crop Manager, 2001, February pgs 42-43.
(21) Later swathing boosts oat quality. Wheat Oats & Barley Guide. March 2001. pp 28.
(22) Oats depend on your wild oat management. Wheat Oats & Barley Guide. March 2001. pp 32-33.
(23) Tradition, Low Disturbance Direct Seeding and Oat Production. Prairie Steward, No 32, Spring, 2001.

PROJECT PHOTOS

ACKNOWLEDGEMENT

To Acknowledge the support from Saskatchewan Agriculture and Food through their Agricultural Development Fund the following actions were taken.

(1) A press release was made
(2) SAF was listed as a sponsor on our field signs
(3) At all presentations and field days SAF was announced as a Sponsor
(4) SAF listed as a Sponsor in written articles